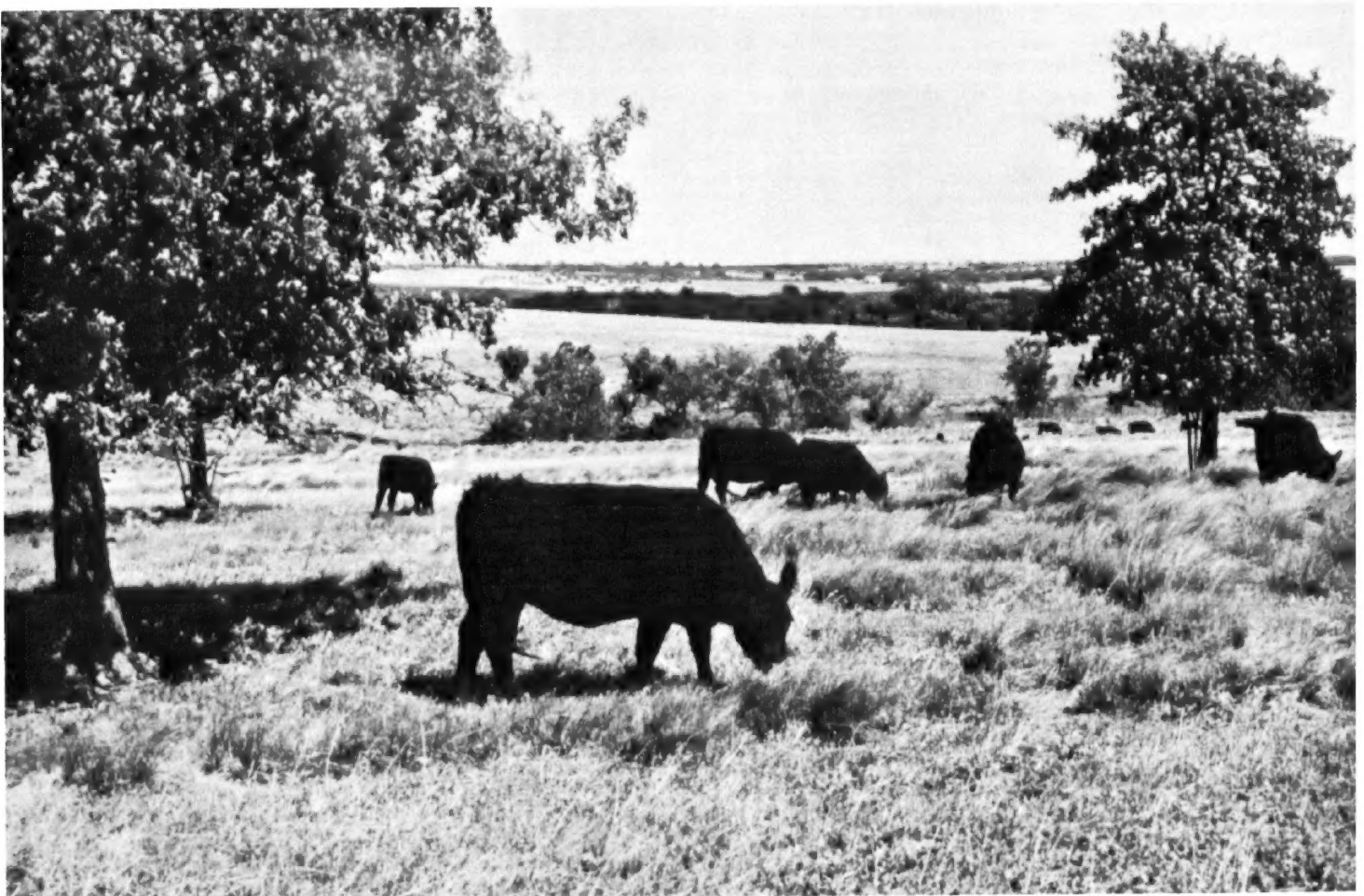


SOIL SURVEY OF
Grady County, Oklahoma



United States Department of Agriculture
Soil Conservation Service
in cooperation with
Oklahoma Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1959-73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1974. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Grady County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, ranching, industry, and recreation.

Locating Soils

All the soils of Grady County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored

yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the information on range and the pasture and hayland groups.

Foresters and others can refer to the section "Windbreaks and Environmental Plantings," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife Habitat."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the sections "Building Site Development" and "Sanitary Facilities."

Engineers and builders can find, under "Soil Properties," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Grady County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication.

Cover picture: Tame pasture on Darnell soil in Stephenville-Darnell complex, 1 to 8 percent slopes.

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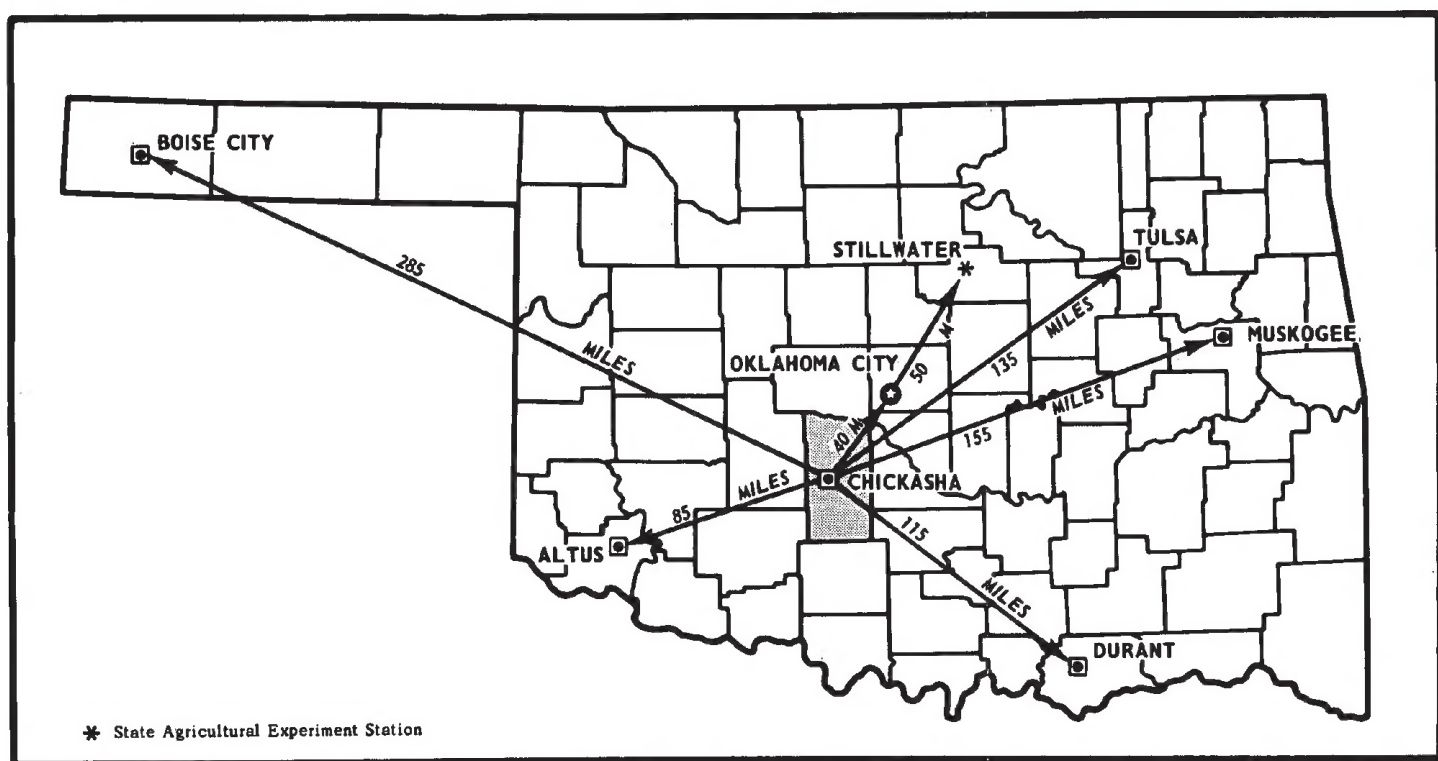
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Location of Grady County in Oklahoma.

SOIL SURVEY OF GRADY COUNTY, OKLAHOMA

By Vinson A. Bogard, Armer G. Fielder and Hadley C. Meinders, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
In Cooperation With Oklahoma Agricultural Experiment Station

GRADY COUNTY is in the south central part of Oklahoma (see facing page). It has an area of 698,880 acres, or 1,092 square miles. It is bordered by the South Canadian River and Canadian County to the north, McClain and Garvin Counties to the east, Stephens County to the south, and Comanche and Caddo Counties to the west. Chickasha, with a population of about 14,000, is the county seat.

Farming is the chief enterprise in the county. Wheat, alfalfa, and grain sorghum are the principal crops. Other important crops are cotton, peanuts, and watermelons. The Kirkland, Grant, and Renfrow soils in the northern half of the county are used mostly for wheat. The sandier Konawa and Dougherty soils in the southern part of the county produce most of the watermelons and peanuts. Alfalfa, a major crop, is grown mainly on Dale, Reinach, McLain, Yahola, and Port soils along the larger streams of the county. Most of the cotton is produced in the northern part of the county on Minco, Norge, and Teller soils.

Livestock production contributes significantly to the total farm income. Most farms breed and raise cattle.

Grady County can be divided into three general soil areas. About 55 percent of the county is prairie uplands, 25 percent is forested uplands, and 20 percent is bottom land. On the prairie uplands, slopes range from 0 to 30 percent, but on nearly 75 percent of the acreage, they are less than 5 percent. On the forested uplands, slopes range from 0 to 20 percent, but on about 70 percent of the acreage, they are less than 5 percent. On the bottom land, slopes are 0 to 3 percent, but on nearly all the acreage, they are less than 1 percent. Most of the county drains into the Washita River, which crosses the county just north of the city of Chickasha.

Farming in Grady County is diversified, and both livestock and crops contribute substantially to total production. About 70 percent of the acreage of Grady County is arable. The rest, though nonarable, can be used for grazing. Crops and livestock provide most of the farm income. Wheat and alfalfa are the major crops. Raising cattle is the major livestock enterprise.

The county is well served by a network of Federal and State highways, two railroads, an airport, and numerous all-weather county roads.

Grady County is active in the production of oil and gas. It also supports several small industries in Chick-

asha and other towns. This diversity of farming and industry contributes to a stable economy.

The temperate, continental climate is marked by rapid changes. Spring is the most changeable season and has the greatest number of severe local storms and the heaviest rains. Long, hot summers are eased by occasional rains and moderate winds. The cooler weather in fall is accompanied by adequate rain in September followed by an increasing number of sunny days. Winters are generally mild and have only brief periods of low temperatures and snow cover.

The mean annual precipitation totals 31.23 inches; the distribution is 3.89 inches in winter, 10.72 inches in spring, 8.68 inches in summer, and 7.94 inches in fall. The mean snow and sleet total is 4.7 inches.

The mean annual temperature is 62° F; the distribution is 41° in winter, 61° in spring, 81° in summer, and 63° in fall.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Grady County, where they are located, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes, the size of streams and the general pattern of drainage, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has been changed very little by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important

characteristics. Soil series commonly are named for towns or other geographic features near the place where they were first observed and mapped. Amber and Minco, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in characteristics.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Grant silt loam, 1 to 3 percent slopes, is one of several phases within the Grant series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a named soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series, and some have little or no soil. These kinds of mapping units are defined and discussed in the section "Soil Maps for Detailed Planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. Existing ratings of suitabilities and limitations (interpretations) of the soils are field tested and modified as necessary during the course of the survey, and new interpretations are added to meet local needs. This is done mainly through field observations of behavior of different kinds of soil for different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and other information available from State and local specialists. For example, data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily useful to different groups of users, among them farmers, managers of woodland and rangeland, engineers, and planners. Presenting the detailed information in an organized, understandable manner is the purpose of this publication.

General Soil Map

The general soil map at the back of this survey

shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey area have been grouped into general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations are described on the pages that follow.

Deep, Loamy, Moderately Rapidly Permeable to Slowly Permeable Soils on Flood Plains

The two associations in this group make up about 19 percent of Grady County. They are used mainly for field crops and tame pasture. Small areas are used for native range.

1. Dale-Reinach-McLain association

Nearly level, well drained and moderately well drained loamy soils

This association is on flood plains. It makes up about 5 percent of Grady County. It is about 38 percent Dale soils, 24 percent Reinach soils, 22 percent McLain soils, and 16 percent Amber, Keokuk, and Lela soils. It is rarely flooded.

Dale soils are nearly level, deep, and well drained. They have a loamy surface layer and subsoil. Permeability is moderate.

Reinach soils are nearly level, deep, and well drained. They have a loamy surface layer and subsoil. Permeability is moderate.

McLain soils are nearly level, deep, and moderately well drained. They have a loamy surface layer and a clayey or loamy subsoil. Permeability is slow.

Available water capacity is high. Nearly all the association is used for field crops. A small part is in tame pasture, and a few small areas are in native range. During periods of heavy rainfall, wetness delays tillage in some areas of McLain soils. Maintaining desirable soil structure and fertility is the main concern of management. The soils respond well to intensive management.

2. Port-Yahola-Gracemont association

Nearly level, well drained and somewhat poorly drained loamy soils

This association is on flood plains. It makes up about 14 percent of Grady County. It is about 40 percent Port soils, 26 percent Yahola soils, 10 percent Gracemont soils, and 24 percent Cyril, Dale, Gracemore, Pocasset, Pulaski, Reinach, Tivoli, and other soils. The association is occasionally flooded.

Port soils are nearly level, deep, and well drained. They have a loamy surface layer and subsoil. Permeability is moderate.

Yahola soils are nearly level, deep, and well drained. They have a loamy surface layer and loamy underlying material. Permeability is moderately rapid.

Gracemont soils are nearly level, deep, and somewhat poorly drained. They have a loamy surface layer and loamy underlying material. Permeability is moderately rapid.

Available water capacity is high or medium. Most of the association is used for field crops or tame pasture. A small part is in native range. Most of the acreage of Gracemont soils is in tame pasture because these soils have a high water table and are wet during rainy periods. Maintaining desirable soil structure and fertility is the main concern of management.

Deep, Loamy, Moderately Permeable to Very Slowly Permeable Soils on Uplands

The two associations in this group make up about 38 percent of Grady County. They are used mostly for field crops and tame pasture and less extensively for native range.

3. Renfrow-Kirkland-Bethany association

Nearly level to gently sloping, well drained loamy soils

This association is on uplands. It makes up about 8 percent of Grady County. It is about 57 percent Renfrow soils, 15 percent Kirkland soils, 15 percent Bethany soils, and 13 percent Hinkle, Grant, Norge, Pond Creek, Port, Zaneis, and other soils.

Renfrow soils are very gently sloping and gently sloping and are deep. They have a loamy surface layer and a clayey subsoil. In some areas they are severely eroded. Permeability is very slow.

Kirkland soils are nearly level and deep. They have a loamy surface layer and a clayey subsoil. Permeability is very slow.

Bethany soils are nearly level and deep. They have a loamy surface layer and a clayey subsoil. Permeability is slow.

Available water capacity is medium or high. Most of the association is used for field crops. Wheat, cotton, and grain sorghum are the main crops. The more eroded soils are in native range and tame pasture. Maintaining soil structure, increasing the intake of water, and controlling water erosion are the main concerns of management.

4. Grant-Minco-Zaneis association

Nearly level to sloping, well drained loamy soils

This association is on uplands. It makes up about 30 percent of Grady County. It is about 26 percent Grant soils, 22 percent Minco soils, 18 percent Zaneis soils, and 34 percent Bethany, Kirkland, Nash, Norge, Pond

Creek, Port, Quinlan, Renfrow, Teller, Yahola, and other soils.

Grant soils are dominantly very gently sloping and gently sloping, but range to sloping and strongly sloping. They are deep. They have a loamy surface layer and a loamy subsoil. Permeability is moderate.

Minco soils are dominantly nearly level to sloping, but range to strongly sloping and steep. They are deep. They have a loamy surface layer and subsoil. Permeability is moderate.

Zaneis soils are very gently sloping to sloping and deep. They have a loamy surface layer and subsoil. Permeability is moderately slow.

Available water capacity is high. The association is used about equally for crops and tame pasture. Some areas are in native range. Wheat, grain sorghum, and cotton are the main crops. Maintaining desirable soil structure and fertility and controlling water erosion are the main concerns of management.

Deep and Moderately Deep, Sandy and Loamy, Moderately Rapidly Permeable to Moderately Slowly Permeable Soils on Uplands

The two associations in this group make up about 13 percent of Grady County. They are used mostly for tame pasture and native range and less extensively for field crops.

5. Konawa-Dougherty association

Nearly level to sloping, well drained sandy soils

This association is on uplands. It makes up about 3 percent of Grady County. It is about 60 percent Konawa soils, 20 percent Dougherty soils, and 20 percent Eufaula, Noble, Stephenville, and other soils.

Konawa soils are nearly level to sloping and deep. They have a sandy surface layer and a loamy subsoil. Permeability is moderate.

Dougherty soils are nearly level to sloping and deep. They have a thick, sandy surface layer and a loamy subsoil. Permeability is moderate.

Available water capacity is medium. The association is mainly used for tame pasture and native range. Some areas are used for cultivated crops, mostly peanuts, watermelons, and grain sorghum. Maintaining or increasing soil fertility and providing protection against soil blowing are the main concerns of management.

6. Stephenville-Noble-Windthorst association

Very gently sloping and gently sloping, mainly well drained loamy and sandy soils

This association is on uplands. It makes up about 10 percent of Grady County. It is about 65 percent Stephenville soils, 12 percent Noble soils, 8 percent Windthorst soils, and 15 percent Darnell, Dougherty, Gracemont, Gracemore, Konawa, Pulaski, Zaneis, and other soils.

Stephenville soils are dominantly very gently sloping and gently sloping, but range to sloping and moderately steep. They are moderately deep and well drained. They have a loamy or sandy surface layer and a loamy subsoil. Permeability is moderate.

Noble soils are dominantly very gently sloping and gently sloping, but range to sloping and moderately steep. They are deep and well drained. They have a loamy surface layer and subsoil. Permeability is moderately rapid.

Windthorst soils are very gently sloping and gently sloping, deep, and moderately well drained. They have a loamy surface layer and a clayey or loamy subsoil. Permeability is moderately slow.

Available water capacity is medium. The association is used extensively for tame pasture and native range. A few areas are used for cultivated crops, mostly grain sorghum, cotton, peanuts, and watermelons. Maintaining or increasing soil structure and fertility and providing protection against water erosion are the main concerns of management.

Shallow to Deep, Sandy and Loamy, Moderately Permeable to Rapidly Permeable Soils on Uplands

The two associations in this group make up about 30 percent of Grady County. They are used mainly for native range and tame pasture.

7. Stephenville-Eufaula association

Gently sloping to moderately steep, well drained and somewhat excessively drained loamy and sandy soils

This association is on uplands. It makes up about 5 percent of Grady County. It is about 45 percent Stephenville soils, 32 percent Eufaula soils, and 23 percent Gracemont, Gracemore, Grant, Konawa, Minco, Noble, Pulaski, Quinlan, and other soils.

Stephenville soils are gently sloping to moderately steep, moderately deep, and well drained. They have a loamy or sandy surface layer and a loamy subsoil. Permeability is moderate.

Eufaula soils are gently sloping to moderately steep, deep, and somewhat excessively drained. They have a sandy surface layer and subsoil. Permeability is rapid.

Available water capacity is medium or low. The association is used almost entirely for native range and tame pasture. Maintaining fertility and providing an adequate plant cover for control of soil blowing and water erosion are the main concerns of management.

8. Nash-Lucien-Stephenville association

Very gently sloping to moderately steep, well drained loamy and sandy soils

This association is on uplands. It makes up about 25 percent of Grady County. It is about 24 percent Nash soils, 19 percent Lucien soils, 18 percent Stephenville soils, and 39 percent Darnell, Noble, Pulaski, Zaneis, and other soils.

Nash soils are very gently sloping to strongly sloping and moderately deep. They have a loamy surface layer and subsoil. Permeability is moderate.

Lucien soils are very gently sloping to strongly sloping and shallow. They have a loamy surface layer and subsoil. Permeability is moderately rapid.

Stephenville soils are very gently sloping to moderately steep and moderately deep. They have a loamy or sandy surface layer and a loamy subsoil. Permeability is moderate.

Available water capacity is low or medium. The

association is used mostly for native range, but some areas are used for wheat, grain sorghum, cotton, or tame pasture. Maintaining or increasing soil fertility and providing adequate cover to control water erosion are the main concerns of management.

Soil Maps for Detailed Planning

The kinds of soil (mapping units) shown on the detailed soil map at the back of this publication are described in this section. These descriptions, together with the soil map, can be useful in planning and managing the soil for farming, forestry, recreation, construction, waste disposal, and many other uses. More detailed information for each soil is given in the section "Planning the Use and Management of the Soils."

Preceding the name of each mapping unit is the symbol that identifies the unit on the detailed soil map. Each mapping unit description includes general facts about the soil and a brief description of the soil profile. The principal hazards and limitations are indicated, and the management concerns and practices for the major uses are discussed.

A mapping unit represents an area of soil on the landscape. Each unit generally consists of a dominant soil or soils for which it is named. In places the mapping unit also includes small, scattered areas of other soils. The properties of some included soils can differ substantially from those of the dominant soil and thus greatly influence the use of the dominant soil. The included soils may affect the use and management of the mapping unit.

Some mapping units consist of more than one kind of soil, each of which represents a considerable part of the unit. There are two such kinds of mapping units in the survey area: soil complexes and undifferentiated groups.

A soil complex is a mapping unit that consists of areas of two or more soils that occur in such an intricate pattern on the landscape or in such small size that they cannot be shown separately on the soil map. Each area of a complex consists of some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Darnell-Noble complex, 8 to 20 percent slopes, is an example of a soil complex.

An undifferentiated group is a mapping unit made up of two or more soils that could be delineated individually but are shown as one unit because, for the purposes of the soil survey, there is little value in separating them. For example, a single feature common to the soils of the group, such as slope, outweighs all other characteristics of the soils in determining the limits of use for the area. The pattern and proportion of soils are not uniform. An area shown on the map can be made up of only one of the dominant soils or of two or more. Gracemore soils is an example of an undifferentiated group.

In most areas surveyed there is land that has little or no identifiable soil and supports no vegetation. This land, called a miscellaneous area, is delineated on the map and given a descriptive name. Rock outcrop is an example. These miscellaneous areas are listed in the interpretive tables, but no interpretations are provided.

If the need for land requires that miscellaneous areas be used, onsite investigation of individual tracts is required. Areas too small to be delineated are identified by special symbols on the soil map.

The acreage and proportionate extent of each mapping unit are listed in table 1, and additional information on each unit is given in interpretive tables in other sections (see Summary of Tables following Contents). Many terms used in describing soils are defined in the Glossary.

1—Amber very fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on flood plains. It is rarely flooded, but is subject to flooding for very brief periods in spring and fall. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is reddish brown very fine sandy loam about 12 inches thick. The subsoil is yellowish red very fine sandy loam about 24 inches thick. The underlying material is reddish yellow fine sandy loam.

About 10 percent of the total acreage is an included soil that is similar to the Amber soil but has a thicker, dark colored surface layer. About 20 percent is an included soil that is similar but has a sandier subsoil.

This soil is used mainly for cotton, alfalfa, wheat, and grain sorghum. It is suited to tame pasture and peanuts.

Management is needed to control soil blowing and maintain a desirable soil structure. Soil blowing can be controlled by keeping an adequate cover of crop residue on the soil between crops and by seeding crops at right angles to the direction of prevailing winds. Bermudagrass and weeping lovegrass provide good grazing and are effective in controlling soil blowing. Crops, alfalfa, and pasture grasses respond well to applications of fertilizer. Capability unit IIe-1; Loamy Bottomland range site; pasture and hayland group 2A.

2—Bethany silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is slowly permeable. Available water capacity is high. Included in mapping are a few areas of Kirkland and Pond Creek soils.

In a representative profile the surface layer is dark grayish brown silt loam about 14 inches thick. The next layer is dark grayish brown silty clay loam about 10 inches thick. The upper 11 inches of the subsoil is dark grayish brown silty clay, the next 17 inches is brown silty clay, and the lower 12 inches is brown silty clay that has common, distinct, brownish yellow mottles.

The soil is used mainly for wheat, grain sorghum, and cotton. The rest of the acreage is used for alfalfa, tame pasture, and some native range.

Management is needed to maintain soil structure and fertility. The return of crop residue and the annual application of fertilizer are generally adequate to maintain tilth and high fertility on cropland. Bermudagrass and lovegrass respond well to fertilization. Capability unit I-1; Loamy Prairie range site; pasture and hayland group 8A.

3—Cyril fine sandy loam. This nearly level soil is on flood plains. It is occasionally flooded for brief periods in spring and fall. It is moderately permeable. Available water capacity is medium.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 28 inches thick.

The subsoil is grayish brown fine sandy loam about 22 inches thick. The underlying material is strong brown fine sandy loam.

About 10 percent of the total acreage is an included Port soil. About 10 percent is an included soil that is similar to the Cyril soil but has a brown surface layer.

This soil is used mainly for alfalfa, wheat, and grain sorghum. It is also suited to cotton and peanuts. Some areas are in tame pasture and native range.

Maintaining or improving soil structure and fertility and controlling damaging floods are the main concerns of management. Growing crops that are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Periodically changing the depth of tillage and tilling when the soil is not wet reduce the risk of the formation of a tillage pan. Damage from flooding can be reduced by protective measures in all areas. Watershed projects upstream are needed for flood control. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland group 2A.

4—Dale silt loam. This nearly level soil is on flood plains. It is rarely flooded, but is subject to flooding for brief periods in spring and fall. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silt loam about 15 inches thick. The subsoil is reddish brown silt loam about 29 inches thick. The underlying material is yellowish red silty clay loam.

About 15 percent of the total acreage is an included soil that is similar to the Dale soil but has a thinner, dark colored surface layer. A few areas of Reinach and McLain soils are also included in mapping.

This soil is used mostly for alfalfa, cotton, grain sorghum, and wheat. A small acreage is in tame pasture and native range.

Maintaining fertility and desirable soil structure are the main concerns of management. Changing the depth of tillage and tilling when the soil will be least compacted help maintain good soil structure and reduce the risk of the formation of a tillage pan. Fertility can be maintained by returning large amounts of crop residue and by applying adequate kinds and amounts of fertilizer annually. Capability unit I-2; Loamy Bottomland range site; pasture and hayland group 2A.

5—Darnell-Noble complex, 8 to 20 percent slopes. This is a shallow and deep, strongly sloping to moderately steep mapping unit on uplands. It is 35 percent Darnell soil and 35 percent Noble soil. The Darnell soil is on crests and convex side slopes. The Noble soil is below and between ridge crests, on concave side slopes, and on foot slopes. Both soils are moderately rapidly permeable. Available water capacity is low in the Darnell soil and medium in the Noble soil.

About 20 percent of the total acreage is an included soil that is deeper than the Darnell soil but shallower than the Noble soil. About 10 percent is an included Stephenville soil.

In a representative profile of the Darnell soil, the surface layer is brown fine sandy loam about 7 inches thick. The subsoil is yellowish red fine sandy loam about 9 inches thick. The underlying material is red sandstone.

In a representative profile of the Noble soil, the surface layer is brown fine sandy loam about 24 inches

TABLE 1—Approximate acreage and proportionate extent of the soils

Map symbol	Soil name	Acres	Percent
1	Amber very fine sandy loam, 1 to 3 percent slopes	2,121	0.3
2	Bethany silt loam, 0 to 1 percent slopes	9,204	1.3
3	Cyril fine sandy loam	3,912	0.6
4	Dale silt loam	14,059	2.0
5	Darnell-Noble complex, 8 to 20 percent slopes	3,745	0.5
6	Dougherty fine sand, 0 to 3 percent slopes	676	0.1
7	Dougherty-Eufaula complex, 3 to 8 percent slopes	11,435	1.6
8	Eufaula fine sand, 5 to 12 percent slopes	2,335	0.3
9	Eufaula-Stephenville complex, 8 to 20 percent slopes	2,357	0.3
10	Gracemont fine sandy loam	12,637	1.8
11	Gracemore soils	1,868	0.3
12	Grant silt loam, 1 to 3 percent slopes	9,957	1.4
13	Grant silt loam, 3 to 5 percent slopes	8,387	1.2
14	Grant silt loam, 2 to 5 percent slopes, eroded	31,051	4.4
15	Grant-Port complex, 0 to 12 percent slopes	15,886	2.3
16	Keokuk very fine sandy loam	1,252	0.2
17	Kirkland silt loam, 0 to 1 percent slopes	9,340	1.3
18	Konawa loamy fine sand, 0 to 3 percent slopes	11,602	1.7
19	Konawa-Stephenville complex, 2 to 8 percent slopes, severely eroded	9,445	1.3
20	Lela silty clay	1,903	0.3
21	Lucien-Nash complex, 5 to 12 percent slopes	66,630	9.5
22	McLain silty clay loam	8,486	1.2
23	Minco very fine sandy loam, 5 to 8 percent slopes	5,053	0.7
24	Minco very fine sandy loam, 8 to 30 percent slopes	868	0.1
25	Minco silt loam, 0 to 1 percent slopes	2,169	0.3
26	Minco silt loam, 1 to 3 percent slopes	14,019	2.0
27	Minco silt loam, 3 to 5 percent slopes	24,997	3.6
28	Nash loam, 3 to 5 percent slopes	7,494	1.1
29	Nash loam, 5 to 8 percent slopes	8,603	1.2
30	Nash-Lucien complex, 1 to 5 percent slopes	23,555	3.4
31	Noble fine sandy loam, 1 to 3 percent slopes	3,974	0.6
32	Noble-Darnell complex, 3 to 5 percent slopes	9,397	1.3
33	Norge silt loam, 0 to 1 percent slopes	2,580	0.4
34	Norge silt loam, 1 to 3 percent slopes	11,795	1.7
35	Norge silt loam, 2 to 5 percent slopes, eroded	5,026	0.7
36	Pocasset silty clay loam	2,592	0.4
37	Pond Creek silt loam, 0 to 1 percent slopes	3,490	0.5
38	Pond Creek silt loam, 1 to 3 percent slopes	6,029	0.9
39	Port fine sandy loam, overwash	7,360	1.0
40	Port silt loam	31,752	4.5
41	Pulaski fine sandy loam	7,650	1.1
42	Quinlan-Rock outcrop complex, 12 to 30 percent slopes	7,863	1.1
43	Reinach silt loam	8,923	1.3
44	Renfrow silt loam, 1 to 3 percent slopes	11,261	1.6
45	Renfrow silt loam, 2 to 5 percent slopes, eroded	15,558	2.2
46	Renfrow silt loam, 2 to 5 percent slopes, severely eroded	5,089	0.7
47	Renfrow-Hinkle complex, 1 to 3 percent slopes	2,580	0.4
48	Stephenville fine sandy loam, 1 to 3 percent slopes	7,690	1.1
49	Stephenville fine sandy loam, 3 to 5 percent slopes	23,002	3.3
50	Stephenville fine sandy loam, 2 to 5 percent slopes, eroded	22,294	3.2
51	Stephenville fine sandy loam, 2 to 8 percent slopes, severely eroded	19,400	2.8
52	Stephenville-Darnell complex, 1 to 8 percent slopes	20,222	2.9
53	Stephenville-Eufaula complex, 3 to 8 percent slopes	20,700	3.0
54	Stephenville-Pulaski complex, 0 to 12 percent slopes	3,855	0.6
55	Teller loam, 1 to 3 percent slopes	6,685	1.0
56	Teller loam, 3 to 5 percent slopes	2,723	0.4
57	Teller loam, 2 to 5 percent slopes, eroded	11,007	1.6
58	Teller loam, 5 to 8 percent slopes	2,691	0.4
59	Tivoli loamy fine sand	785	0.1
60	Windthorst fine sandy loam, 1 to 3 percent slopes	4,335	0.6
61	Windthorst fine sandy loam, 2 to 5 percent slopes, eroded	2,261	0.3
62	Yahola fine sandy loam	26,526	3.8
63	Zaneis loam, 1 to 3 percent slopes	5,959	0.9
64	Zaneis loam, 3 to 5 percent slopes	2,566	0.4
65	Zaneis loam, 2 to 5 percent slopes, eroded	27,650	4.0
66	Zaneis loam, 2 to 8 percent slopes, severely eroded	20,564	2.9
Total		698,880	100.0

thick. The subsoil is reddish brown fine sandy loam about 31 inches thick. The underlying material is red fine sandy loam.

Most of the acreage is used for native range. Shallowness over bedrock and strong slopes make these soils unsuitable for cultivation. The quality of native grass can be maintained or improved by controlling brush and grazing and by providing protection against fire. Native trees are of poor quality and grow slowly. Capability unit VIIe-1; Darnell soil in Shallow Savannah range site, Noble soil in Sandy Savannah range site; not assigned to a pasture and hayland group.

6—Dougherty fine sand, 0 to 3 percent slopes. This nearly level to very gently sloping soil is on uplands. It is moderately permeable. Available water capacity is medium.

In a representative profile the surface layer is pale brown fine sand about 8 inches thick. The subsurface layer is pink fine sand about 22 inches thick. The upper 18 inches of the subsoil is yellowish red sandy clay loam, and the lower 10 inches is reddish yellow fine sandy loam. The underlying material is reddish yellow fine sandy loam.

About 20 percent of the total acreage is an included Konawa soil. About 15 percent is an included soil that is similar to the Dougherty soil but has a thicker surface and subsurface layer.

This soil is used mainly for peanuts and grain sorghum. It is also suited to wheat, watermelons, tame pasture, and native range.

Controlling soil blowing and maintaining fertility are the main concerns of management. Soil blowing can be controlled by keeping a growing crop or a cover of crop residue on the surface throughout the year, using a deep furrow drill, and seeding crops at right angles to the direction of the prevailing winds. If this soil is adequately fertilized, weeping lovegrass can be grown. Crops respond to fertilization. For suggested pasture management, refer to "Pasture and Hay." For native range, refer to "Range." Capability unit IVs-2; Deep Sand Savannah range site; pasture and hayland group 9A.

7—Dougherty-Eufaula complex, 3 to 8 percent slopes. This is a deep, gently sloping to sloping mapping unit on uplands. It is about 40 percent Dougherty soil and 25 percent Eufaula soil. The Dougherty soil is on the lower half of side slopes and on foot slopes. The Eufaula soil is on crests of ridges. The Dougherty soil is moderately permeable and has medium available water capacity. The Eufaula soil is rapidly permeable and has low available water capacity.

About 20 percent of the total acreage is an included soil that is similar to the Dougherty soil but has a thicker surface and subsurface layer. About 15 percent is an included soil that is also similar but has a thinner surface and subsurface layer.

In a representative profile of the Dougherty soil, the surface layer is light brown fine sand about 9 inches thick. The subsurface layer is light reddish brown fine sand about 18 inches thick. The subsoil is red sandy clay loam about 21 inches thick. The underlying material is red fine sandy loam.

In a representative profile of the Eufaula soil, the surface layer is light brown fine sand about 10 inches

thick. The subsurface layer is pink fine sand about 35 inches thick. Below this is pink fine sand that contains bands of reddish brown loamy fine sand $\frac{1}{4}$ to 1 inch thick and 1 inch to 4 inches apart.

Most of the acreage is used for tame pasture and native range. This unit is also suited to wheat and watermelons.

Management is needed to control erosion and maintain and improve fertility. Growing crops that produce a large amount of residue and returning all residue decrease the hazard of erosion and increase the intake of water and supply of organic matter. Soil blowing can be reduced if cover crops are grown in winter following the harvest of row crops that leave little residue. Delaying tillage in spring during the period of critical soil blowing helps to maintain a vegetative cover. Crops respond to applications of fertilizer.

Diversion terraces are needed to protect fields from runoff from higher lying areas. Excess water can be safely removed through waterways and natural drainageways in which perennial grasses have been established. Field windbreaks help to control soil blowing. For suggested tame pasture management and suitable plants, refer to "Pasture and Hay." For range, refer to "Range." Capability unit IVe-3; Deep Sand Savannah range site; Dougherty soil in pasture and hayland group 9A, Eufaula soil in group 9B.

8—Eufaula fine sand, 5 to 12 percent slopes. This sloping to strongly sloping soil is on uplands. It is rapidly permeable. Available water capacity is low. Included areas of Dougherty soils make up about 10 percent of the total acreage.

In a representative profile the surface layer is pinkish gray fine sand about 6 inches thick. The subsurface layer is pink fine sand about 24 inches thick. Below this is pink fine sand that has alternating bands of red loamy fine sand $\frac{1}{8}$ inch to 2 inches thick and 1 to 4 inches apart.

This soil is not suitable for cultivation and is used mainly for native range. A small part of the acreage is in tame pasture.

Management is needed to keep a plant cover on the soil at all times to prevent soil blowing. For suggested range management, refer to "Range." For tame pasture, refer to "Pasture and Hay." Capability unit VIe-1; Deep Sand Savannah range site; pasture and hayland group 9B.

9—Eufaula-Stephenville complex, 8 to 20 percent slopes. This is a deep and moderately deep mapping unit on uplands. It is about 45 percent Eufaula soil and 25 percent Stephenville soil. The Eufaula soil is in concave areas and on foot slopes. The Stephenville soil is on the upper half of side slopes and on crests. The Eufaula soil is rapidly permeable and has low available water capacity. The Stephenville soil is moderately permeable and has medium available water capacity.

About 10 percent of the total acreage is an included Dougherty soil, and about 10 percent is an included Darnell soil. About 10 percent is an included soil that is similar to the Darnell soil but is more than 20 inches deep over sandstone.

In a representative profile of the Eufaula soil, the surface layer is grayish brown fine sand about 8 inches thick. The subsurface layer is very pale brown fine sand about 22 inches thick. Below this is pink fine sand

that has alternating bands of reddish brown loamy fine sand $\frac{1}{4}$ inch to 2 inches thick and 1 inch to 4 inches apart.

In a representative profile of the Stephenville soil, the surface layer is brown loamy fine sand about 6 inches thick. The subsurface layer is pinkish gray loamy fine sand about 9 inches thick. The subsoil is red sandy clay loam about 23 inches thick. The underlying material is red sandstone.

Most of the acreage is used for native range and tame pasture. Management is needed to keep a plant cover on the soil at all times to help control soil blowing. In areas that are in tame pasture, lovegrass is well suited. For suggested range management, refer to "Range." For tame pasture, refer to "Pasture and Hay." Capability unit VIe-2; Deep Sand Savannah range site; Eufaula soil in pasture and hayland group 9B, Stephenville soil in group 9A.

10—Gracemont fine sandy loam. This nearly level soil is on flood plains. It is occasionally flooded for brief periods in spring and fall. It is moderately rapidly permeable. Available water capacity is high. During most of the year the water table is at a depth of $\frac{1}{2}$ foot to 3 feet, but during wet periods it is commonly above 20 inches.

In a representative profile the surface layer is brown fine sandy loam about 10 inches thick. The underlying material to a depth of 28 inches is light brown fine sandy loam. The next 18 inches is dark gray fine sandy loam. Below this to a depth of 72 inches is pale brown fine sandy loam.

About 15 percent of the total acreage is an included soil that is similar to the Gracemont soil but is non-calcareous between depths of 10 and 40 inches. About 10 percent is an included soil that is similar but has a surface layer of loamy fine sand. About 10 percent is an included Pulaski soil.

This soil is used mainly for tame pasture, but it is also suited to grain sorghum, wheat, cotton, and alfalfa. A few areas are in native range.

Maintaining or improving soil fertility, controlling floods, and lowering the water table in cultivated areas are the main concerns of management. Growing crops that are high in residue, returning the residue to the soil, and adding adequate amounts of fertilizer help to maintain or increase soil fertility. Damage from flooding can be reduced by watershed projects upstream for flood control. The water table can be lowered by straightening and deepening the stream channel. Capability unit IIIw-1; Subirrigated range site; pasture and hayland group 2B.

11—Gracemore soils. This nearly level mapping unit is on flood plains. It is frequently flooded for very brief periods in spring and summer. It is moderately rapidly permeable. Available water capacity is medium above the water table. During most of the year the water table is at a depth of $\frac{1}{2}$ foot to 8 feet. About 15 percent of the total acreage is an included Gracemont soil.

In a representative profile the surface layer is light brown loamy fine sand about 10 inches thick. The underlying material to a depth of 40 inches is pink loamy fine sand. Below this it is pink fine sand.

These soils are used mainly for range. A few areas are in tame pasture.

Management is needed to control flooding, lower the high water table, and maintain or improve soil fertility. Because of the frequency of flooding, these soils are better suited to native range or tame pasture than to other uses. For suggested native range management, refer to "Range." For tame pasture, refer to "Pasture and Hay." Capability unit Vw-1; Subirrigated range site; pasture and hayland group 3B.

12—Grant silt loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is brown silt loam about 12 inches thick. The next layer is reddish brown silt loam about 4 inches thick. The upper 8 inches of the subsoil is reddish brown silty clay loam, and the lower 26 inches is red silty clay loam. The underlying material is red and reddish brown soft siltstone.

Included with this soil in mapping are small areas of soils that are similar to the Grant soil but are less than 40 inches thick over siltstone. Also included are small areas of Zaneis and Nash soils.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to tame pasture and alfalfa. A few areas are in native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Water erosion can be controlled by keeping an adequate cover of crop residue on the surface. Where this cover is not adequate, terraces are needed. Additional fertilization is needed if crop residue is to be returned to the soil or left on the surface. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland group 8A.

13—Grant silt loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silt loam about 9 inches thick. The upper 5 inches of the subsoil is reddish brown silt loam, the next 26 inches is yellowish red silt loam, and the lower 5 inches is red silt loam. The underlying material is red siltstone.

About 15 percent of the total acreage is an included soil that is similar to the Grant soil but is less than 40 inches thick over bedrock. Also included are small areas of Nash and Zaneis soils.

This soil is used mainly for wheat, grain sorghum, and cotton. Some areas are in tame pasture and native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Runoff and erosion can be reduced by installing terraces and by farming on the contour. The terraces can be more widely spaced if adequate conservation practices are used. Maintaining an adequate cover of crop residue on the surface at seeding time also helps to control water erosion. Applications of fertilizer are needed if a large amount of crop residue is to be returned to the soil or left on the surface. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland group 8A.

14—Grant silt loam, 2 to 5 percent slopes, eroded. This very gently sloping to gently sloping soil is on uplands. It is moderately permeable. Available water

capacity is high. This soil is so eroded that on about 40 percent of the acreage the plow layer is a mixture of material from the original surface layer and the upper part of the subsoil. Small rills and a few shallow gullies have formed in most areas.

In a representative profile the surface layer is reddish brown silt loam about 6 inches thick. The upper 4 inches of the subsoil is dark reddish brown silty clay loam, the next 16 inches is reddish brown silty clay loam, and the lower 20 inches is red silt loam. The underlying material is red siltstone.

About 35 percent of the total acreage is an included soil that is similar to the Grant soil but has a thinner, dark colored surface layer. About 10 percent is an included soil that is similar but is less than 40 inches thick over bedrock.

This soil is used mostly for grain sorghum, tame pasture, and native range. It is also suited to wheat and cotton.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Terraces can be used to control water erosion. They can be more widely spaced if the surface is protected by a cover of crop residue. Fertilization is needed to maintain soil fertility. It also helps crops to produce the residue needed to protect the soil against erosion. Capability unit IIIe-3; Loamy Prairie range site; pasture and hayland group 8A.

15—Grant-Port complex, 0 to 12 percent slopes. This is a deep, nearly level to strongly sloping mapping unit. It is about 50 percent Grant soil and 25 percent Port soil. The gently sloping to strongly sloping Grant soil is on uplands. The nearly level Port soil is on flood plains. Both are moderately permeable and have high available water capacity.

About 10 percent of the total acreage is an included soil that is similar to the Grant soil but is less than 40 inches thick over bedrock. About 15 percent is an included soil that is similar to the Port soil but has a thinner, dark colored surface layer.

In a representative profile of the Grant soil, the surface layer is reddish brown silt loam about 8 inches thick. The subsoil is red silty clay loam and silt loam about 37 inches thick. The underlying material is red siltstone.

In a representative profile of the Port soil, the surface layer is brown silt loam about 27 inches thick. The subsoil is reddish brown silty clay loam about 15 inches thick. The underlying material is red silt loam.

Most of the acreage is used for tame pasture and native range. Strong slopes and the frequency of flooding make these soils undesirable for cultivation. The amount of forage provided can be increased by controlling grazing and brush and providing protection from fire. For suggested range management, refer to "Range." For suggested tame pasture management and suitable grasses, refer to "Pasture and Hay." Capability unit VIe-3; Grant soil in Loamy Prairie range site and pasture and hayland group 8A; Port soil in Loamy Bottomland range site and pasture and hayland group 2A.

16—Keokuk very fine sandy loam. This nearly level soil is on flood plains. It is rarely flooded, but is subject to flooding for very brief periods in spring and fall. It is moderately permeable. Available water capacity is

high. Included in mapping are small areas of a soil that is similar but has a sandier subsoil.

In a representative profile the surface layer is brown very fine sandy loam about 13 inches thick. The subsoil is light brown very fine sandy loam about 15 inches thick. The underlying material is light reddish brown very fine sandy loam.

This soil is mainly used for cotton, alfalfa, grain sorghum, and wheat. A few areas are used for peanuts, tame pasture, and native range.

Maintaining soil fertility and desirable structure are the main concerns of management. Changing the depth of tillage and tilling at a time when least compaction is likely to occur help to maintain good soil structure and reduce the risk of the formation of a tillage pan. High soil fertility can be maintained by returning large amounts of crop residue and by applying adequate kinds and amounts of fertilizer annually. Capability unit 1-2; Loamy Bottomland range site; pasture and hayland group 2A.

17—Kirkland silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is very slowly permeable. Available water capacity is medium.

In a representative profile the surface layer is dark grayish brown silt loam about 10 inches thick. The upper 32 inches of the subsoil is dark grayish brown silty clay, and the lower 30 inches is brown silty clay. The underlying material is red soft clayey shale.

About 10 percent of the total acreage is an included Renfrow soil. About 10 percent is an included Bethany soil.

This soil is used mainly for wheat, grain sorghum, and cotton. A small acreage is in native range and tame pasture.

Management is needed to reduce surface crusting and maintain or improve fertility and soil structure. Growing crops, such as small grain, that produce large amounts of residue and working the residue into the soil helps to control erosion, break up surface crusting, and increase water intake. Additional fertilization helps in maintaining soil fertility. In areas where the soil has long slopes, terraces help to reduce runoff. Capability unit IIs-1; Claypan Prairie range site; pasture and hayland group 8C.

18—Konawa loamy fine sand, 0 to 3 percent slopes. This nearly level to very gently sloping soil is on uplands. It is moderately permeable. Available water capacity is medium. Included areas of Dougherty soils make up about 10 percent of the total acreage.

In a representative profile the surface layer is grayish brown loamy fine sand about 5 inches thick. The subsurface layer is pale brown loamy fine sand about 7 inches thick. The upper 18 inches of the subsoil is reddish brown sandy clay loam, the next 14 inches is yellowish red sandy clay loam, and the lower 12 inches is reddish yellow fine sandy loam. The underlying material is yellowish red fine sandy loam.

This soil is used mainly for peanuts, grain sorghum, watermelons, tame pasture, and native range. It is also suited to cotton and alfalfa.

Management is needed to maintain or improve fertility and control soil blowing. A suitable cropping system is needed to provide plant cover during winter and spring to protect the soil from blowing. Cover crops or crops that produce large amounts of residue

are needed. Stripcropping, minimum tillage, and return of crop residue improve fertility and help to control erosion. Adequate fertilization ensures larger amounts of crop residue. Capability unit IIIe-6; Deep Sand Savannah range site; pasture and hayland group 9A.

19—Konawa-Stephenville complex, 2 to 8 percent slopes, severely eroded. This is a deep and moderately deep, very gently sloping to sloping mapping unit on uplands. It is about 55 percent Konawa soil and 35 percent Stephenville soil. The Konawa soil is on the lower half of side slopes and on foot slopes. The Stephenville soil is on the upper half and on crests. Both are moderately permeable and have medium available water capacity. Both are so eroded that further cultivation is impractical. The present surface layer is a mixture of the original surface layer and subsoil material. Many gullies have formed, some of which are uncrossable with farm machinery.

About 5 percent of the total acreage is an included Dougherty soil. About 5 percent is an included Darnell soil.

In a representative profile of the Konawa soil, the surface layer is light reddish brown loamy fine sand about 10 inches thick. The upper 14 inches of the subsoil is yellowish red sandy clay loam, and the lower 22 inches is red and yellowish red sandy clay loam. The underlying material is reddish yellow fine sandy loam.

In a representative profile of the Stephenville soil, the surface layer is brown fine sandy loam about 5 inches thick. The upper 21 inches of the subsoil is reddish brown sandy clay loam, and the lower 10 inches is red sandy clay loam. The underlying material is yellowish red sandstone.

Most of the acreage is used for native range. A small acreage is in tame pasture.

Because of gullies, tame pasture is difficult to establish. The addition of fertilizer is important for a good plant cover. For suggested tame pasture management and suitable grasses, refer to "Pasture and Hay." For native range, refer to "Range." Capability unit VIe-4; Eroded Sandy Savannah range site; pasture and hayland group 8F.

20—Lela silty clay. This nearly level soil is on flood plains. It is occasionally flooded. It is very slowly permeable. Available water capacity is medium.

In a representative profile the surface layer is dark brown silty clay about 16 inches thick. The upper 14 inches of the subsoil is dark reddish gray silty clay that has cracks filled with darker soil from above, and the lower 30 inches is reddish brown silty clay. The underlying material is reddish brown clay.

About 10 percent of the total acreage is an included McLain soil. About 15 percent is an included soil that is similar to the Lela soil but is calcareous throughout.

This soil is used mainly for wheat and grain sorghum. It is also suited to alfalfa, cotton, tame pasture, and range.

Improving drainage and maintaining or improving soil structure and fertility are important management needs. Growing crops that are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Not tilling when the soil is wet reduces damage to soil structure and reduces crusting on the surface. Capability unit

IIIw-2; Heavy Bottomland range site; pasture and hayland group 1A.

21—Lucien-Nash complex, 5 to 12 percent slopes. This is a shallow and moderately deep, sloping to strongly sloping mapping unit on uplands. It is about 40 percent Lucien soil and 30 percent Nash soil. The Lucien soil is on the crests of ridges and on upper side slopes. The Nash soil is on side slopes and foot slopes. The Lucien soil is moderately rapidly permeable and has low available water capacity. The Nash soil is moderately permeable and has medium available water capacity.

About 20 percent of the total acreage is an included soil that is similar to the Lucien soil but has a thinner surface layer. About 10 percent is an included Quinlan soil.

In a representative profile of the Lucien soil, the surface layer is reddish brown silt loam about 7 inches thick. The subsoil is red silt loam about 11 inches thick. The underlying material is red sandstone.

In a representative profile of the Nash soil, the surface layer is brown silt loam about 10 inches thick. The subsoil is red silt loam about 16 inches thick. The underlying material is red sandstone.

Most of the acreage is used for native range. A few areas are in tame pasture. For suggested range management, refer to "Range." For suggested tame pasture management and suitable grasses, refer to "Pasture and Hay." Capability unit VIe-5; Lucien soil in Shallow Prairie range site and pasture and hayland group 14A; Nash soil in Loamy Prairie range site and pasture and hayland group 8A.

22—McLain silty clay loam. This nearly level soil is on flood plains. It is rarely flooded, but is subject to flooding for brief periods in spring and fall. It is slowly permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silty clay loam about 11 inches thick. The subsoil is reddish brown silty clay about 39 inches thick. The underlying material is reddish brown silty clay loam.

About 10 percent of the total acreage is an included soil that is similar to the McLain soil but has dark colors to a depth of less than 20 inches. Also included are small areas of Dale soils.

This soil is used mostly for cotton, alfalfa, grain sorghum, and wheat. A few areas are in tame pasture and range.

Maintaining desirable soil structure and fertility are the main concerns of management. Changing the depth of tillage and tilling at a time when least compaction is likely to occur help to maintain good soil structure and reduce the risk of the formation of a tillage pan. In some areas proper row direction is important for good drainage of surface water. A high level of fertility can be maintained by returning large amounts of crop residue and by applying adequate amounts of fertilizer annually. Capability unit I-2; Heavy Bottomland range site; pasture and hayland group 2A.

23—Minco very fine sandy loam, 5 to 8 percent slopes. This sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown very fine sandy loam about 10 inches thick. The subsoil is reddish brown loam about 32 inches thick.

The underlying material is yellowish red very fine sandy loam.

About 20 percent of the total acreage is an included soil that is similar to the Minco soil but has a thinner, dark colored surface layer. About 15 percent is an included soil that is similar but has a sandier subsoil.

This soil is used mainly for wheat and grain sorghum. The rest of the acreage is in tame pasture and native range.

Management is needed to control water erosion and maintain or improve soil structure. Growing crops that produce large amounts of residue and returning all residue protects the soil against erosion and reduces crusting. A suitable cropping system that reduces runoff and maintains or improves soil structure is one of row crops followed by cover crops in winter. Other practices that reduce runoff are terracing, tilling on the contour, and using grassed waterways. Capability unit IVE-2; Loamy Prairie range site; pasture and hayland group 8A.

24—Minco very fine sandy loam, 8 to 30 percent slopes. This strongly sloping to steep soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is brown very fine sandy loam about 8 inches thick. The subsoil is reddish brown very fine sandy loam about 34 inches thick. The underlying material is reddish brown very fine sandy loam.

About 20 percent of the total acreage is an included soil that is similar to the Minco soil but has a sandier subsoil. About 20 percent is an included soil that is similar but has a thicker, dark colored surface layer.

This soil is used mainly for native range, but a few small areas are in tame pasture. Strong to steep slopes make these soils unsuitable for cultivation. The quality and quantity of native grasses can be maintained or improved by controlling grazing and by providing protection from fire. For other range management, refer to "Range." Capability unit VIe-6; Loamy Prairie range site; pasture and hayland group 8A.

25—Minco silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silt loam about 17 inches thick. The subsoil is brown silt loam about 33 inches thick. The underlying material is reddish brown silt loam.

About 40 percent of the total acreage is an included soil that is similar to the Minco soil but is dark brown to a depth of more than 20 inches. Also included are small areas of Pond Creek and Teller soils.

This soil is used mainly for wheat, grain sorghum, and cotton. It is also suited to tame pasture, native range, peanuts, and alfalfa.

Management is needed to maintain soil structure and fertility. The return of crop residue and the annual application of fertilizer are important in maintaining a high level of fertility on cropland. Lovegrass and bermudagrass respond well to applications of fertilizer. Capability unit I-1; Loamy Prairie range site; pasture and hayland group 8A.

26—Minco silt loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silt loam about 15 inches thick. The upper 9 inches of the subsoil is reddish brown silt loam, and the lower 31 inches is light reddish brown and red silt loam. The underlying material is red silt loam.

About 10 percent of the total acreage is an included Grant soil. About 5 percent is an included soil that is similar to the Minco soil but has a thicker, dark colored surface layer.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to native range, peanuts, alfalfa, and tame pasture.

Controlling erosion and maintaining desirable soil structure and fertility are the main concerns of management. The risk of erosion can be reduced by keeping an adequate cover of crop residue on the surface. Where this cover is not adequate, terraces are needed. Additional fertilizer should be applied where crop residue is returned to the soil or left on the surface. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland group 8A.

27—Minco silt loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silt loam about 12 inches thick. The subsoil is reddish brown silt loam about 23 inches thick. The underlying material is reddish brown silt loam.

About 25 percent of the total acreage is an included soil that is similar to the Minco soil but has a thinner surface layer. Also included are small areas of Teller soils.

This soil is used mainly for cotton, grain sorghum, and wheat. It is also suited to tame pasture, peanuts, and native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Runoff and erosion can be reduced by installing terraces and by farming on the contour. The terraces can be more widely spaced if adequate conservation practices are used. Maintaining an adequate cover of crop residue on the surface at seeding time also helps to control water erosion. Applications of fertilizer are needed if a large amount of crop residue is to be returned to the soil or left on the surface. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland group 8A.

28—Nash loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. It is moderately permeable. Available water capacity is medium. Included areas of Grant and Lucien soils make up about 5 percent of the total acreage.

In a representative profile the surface layer is reddish brown loam about 12 inches thick. The upper 18 inches of the subsoil is yellowish red loam, and the lower 4 inches is red loam. The underlying material is red soft sandstone.

This soil is used mainly for wheat, grain sorghum, and cotton. Some areas are in tame pasture and native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Runoff and erosion can be reduced by installing terraces and by farming on the contour. The terraces can be more widely spaced if adequate conser-

vation practices are used. Maintaining an adequate cover of crop residue on the surface at seeding time also helps to control water erosion. Applications of fertilizer are needed if a large amount of crop residue is to be returned to the soil or left on the surface. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland group 8A.

29—Nash loam, 5 to 8 percent slopes. This sloping soil is on uplands. It is moderately permeable. Available water capacity is medium.

In a representative profile the surface layer is reddish brown loam about 11 inches thick. The upper 15 inches of the subsoil is reddish brown loam, and the lower 7 inches is red loam. The underlying material is red sandstone.

About 15 percent of the total acreage is an included Lucien soil, and about 5 percent is an included Grant soil. About 10 percent is an included soil that is similar to the Nash soil but has a sandier subsoil.

This soil is used mainly for tame pasture and native range. A small acreage is used for grain sorghum and wheat.

Management is needed to control water erosion and maintain or improve soil structure. Growing crops that produce large amounts of residue and returning all residue protects the soil against erosion and reduces crusting. A suitable cropping system that reduces runoff and maintains or improves soil structure is one of row crops followed by cover crops in winter. Other practices that reduce runoff are terracing, tilling on the contour, and using grassed waterways. For suggested tame pasture management, refer to "Pasture and Hay." For range, refer to "Range." Capability unit IVe-2; Loamy Prairie range site; pasture and hayland group 8A.

30—Nash-Lucien complex, 1 to 5 percent slopes. This is a moderately deep and shallow, very gently sloping to gently sloping mapping unit on uplands. It is about 40 percent Nash soil and 30 percent Lucien soil. The Nash soil is on the sides of ridges. The Lucien soil is on the crests of ridges. The Nash soil is moderately permeable and has medium available water capacity. The Lucien soil is moderately rapidly permeable and has low available water capacity.

About 20 percent of the total acreage is an included soil that is similar to the Nash soil but has a lighter colored surface layer. About 10 percent is an included Quinlan soil.

In a representative profile of the Nash soil, the surface layer is reddish brown loam about 11 inches thick. The upper 13 inches of the subsoil is reddish brown loam, and the lower 4 inches is red loam. The underlying material is red sandstone.

In a representative profile of the Lucien soil, the surface layer is reddish brown silt loam about 7 inches thick. The subsoil is red silt loam about 11 inches thick. The underlying material is red siltstone or sandstone.

Most of the acreage is used for tame pasture and native range. Some is used for wheat and grain sorghum.

Management is needed to control erosion, maintain or improve soil structure and fertility, and minimize limitations imposed by shallowness of the soil over bedrock. Growing crops that produce large amounts of residue and returning all residue protects the soil

against erosion and reduces crusting. A suitable cropping system that reduces runoff and maintains or improves soil structure is one of row crops followed by cover crops in winter. Other practices that reduce runoff are terracing, tilling on the contour, and using grassed waterways. For suggested pasture management, refer to "Pasture and Hay." For range, refer to "Range." Capability unit IVe-2; Nash soil in Loamy Prairie range site and pasture and hayland group 8A; Lucien soil in Shallow Prairie range site and pasture and hayland group 14A.

31—Noble fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately rapidly permeable. Available water capacity is medium.

In a representative profile the surface layer is reddish brown fine sandy loam about 18 inches thick. The subsoil is red fine sandy loam about 26 inches thick. The underlying material is light red fine sandy loam.

About 15 percent of the total acreage is an included soil that is similar to the Noble soil but has sandstone at a depth of 40 to 60 inches. About 10 percent is an included soil that is similar but has a subsoil of sandy clay loam.

This soil is used mainly for peanuts, watermelons, grain sorghum, and tame pasture. It is also suited to native range, wheat, cotton, and alfalfa.

Management is needed to control erosion and maintain or improve soil fertility and structure. Soil blowing is a hazard if the soil surface is left bare. A cropping system that provides maximum use of crop residue as a protective cover, a cover crop of legumes following harvest of peanuts, or stubble mulching following harvest of small grain all help to control soil blowing. Terracing and contour farming help to control water erosion. Changing the depth of tillage reduces the risk of the formation of a plowpan. Crops respond well to applications of fertilizer. Capability unit IIe-2; Sandy Savannah range site; pasture and hayland group 8A.

32—Noble-Darnell complex, 3 to 5 percent slopes. This is a deep and shallow, gently sloping mapping unit on uplands. It is about 50 percent Noble soil and 30 percent Darnell soil. The Noble soil is on concave side slopes and foot slopes. The Darnell soil is on crests and convex side slopes. Both are moderately rapidly permeable. Available water capacity is medium in the Noble soil and low in the Darnell soil. About 20 percent of the total acreage is an included soil that is shallower than the Noble soil but deeper than the Darnell soil.

In a representative profile of the Noble soil, the surface layer is reddish brown fine sandy loam about 12 inches thick. The subsoil is reddish brown fine sandy loam about 26 inches thick. The underlying material is red fine sandy loam.

In a representative profile of the Darnell soil, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is light reddish brown fine sandy loam about 12 inches thick. The underlying material is red sandstone.

This unit is used mostly for tame pasture and native range. It is also suited to grain sorghum, wheat, cotton, and peanuts.

Management is needed to control water erosion,

maintain or improve soil structure and fertility, and minimize limitations imposed by the shallowness of the soil over bedrock in some areas. Growing crops that produce large amounts of residue and returning all residue protects the soil against erosion and reduces crusting. A suitable cropping system that reduces runoff and maintains or improves soil structure is one of row crops followed by cover crops in winter. Other practices that reduce runoff are terracing, tilling on the contour, and using grassed waterways. For suggested tame pasture management, refer to "Pasture and Hay." For range, refer to "Range." Capability unit IVe-2; Noble soil in Sandy Savannah range site and pasture and hayland group 8A; Darnell soil in Shallow Savannah range site and pasture and hayland group 14A.

33—Norge silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is moderately slowly permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown silt loam about 11 inches thick. The upper 23 inches of the subsoil is reddish brown silt loam and silty clay loam, and the lower 30 inches is yellowish red silty clay loam.

About 10 percent of the total acreage is an included Teller soil. About 10 percent is an included soil that is similar to the Norge soil but has a thicker, dark colored surface layer.

This soil is used mainly for wheat, grain sorghum, and cotton. It is also suited to alfalfa, tame pasture, and range.

Management is needed to maintain soil structure and fertility. The return of crop residue and the annual application of fertilizer are important in maintaining a high level of fertility on cropland. Lovegrass and bermudagrass respond well to applications of fertilizer. Capability unit I-1; Loamy Prairie range site; pasture and hayland group 8A.

34—Norge silt loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high.

In a representative profile the surface layer is brown silt loam about 11 inches thick. The upper 22 inches of the subsoil is reddish brown silty clay loam, and the lower 32 inches is red silty clay loam.

About 10 percent of the total acreage is an included Teller soil. Also included are small areas of Bethany soil.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to alfalfa and tame pasture. A small acreage is in native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. The risk of water erosion can be reduced by keeping an adequate cover of crop residue on the surface. Where this cover is not adequate, terraces are needed. Additional fertilization is needed if crop residue is to be returned to the soil or left on the surface. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland group 8A.

35—Norge silt loam, 2 to 5 percent slopes, eroded. This very gently sloping to gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high. This soil is eroded, and on about 30 percent of the acreage the surface layer is a

mixture of material from the original surface layer and the upper part of the subsoil. Small rills and a few shallow gullies have formed in most areas.

In a representative profile the surface layer is reddish brown silt loam about 11 inches thick. The upper 35 inches of the subsoil is reddish brown silty clay loam, and the lower 19 inches is red silty clay loam.

About 30 percent of the total acreage is an included soil that is similar to the Norge soil but has a thinner surface layer. About 5 percent is an included Pond Creek soil.

This soil is used mostly for grain sorghum, tame pasture, and native range. It is also suited to wheat and cotton.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Terraces can be used to control water erosion. They can be more widely spaced if the surface is protected by a cover of crop residue. Fertilization is needed to maintain soil fertility. It also helps crops to produce the residue needed to protect the soil against erosion. Capability unit IIIe-3; Loamy Prairie range site; pasture and hayland group 8A.

36—Pocasset silty clay loam. This nearly level soil is on flood plains. It is occasionally flooded for only brief periods in spring and fall. It is moderately permeable. Available water capacity is medium. Included in mapping are small areas of Yahola and Port soils.

In a representative profile the surface layer is reddish brown silty clay loam about 14 inches thick. The underlying material is reddish yellow fine sandy loam.

This soil is used mainly for alfalfa, wheat, and grain sorghum. It is also suited to cotton, tame pasture, and native range.

Maintaining or improving soil structure and fertility and controlling damaging floods are the main concerns of management. Growing crops that are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Periodically changing the depth of tillage and tilling when the soil is not wet reduce the risk of the formation of a tillage pan. In some areas proper row direction is important for good drainage of surface water. Damage from flooding can be reduced by protective measures in all areas, for example, by watershed projects upstream for flood control and by farm ponds. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland group 2A.

37—Pond Creek silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It is moderately slowly permeable. Available water capacity is high.

In a representative profile the surface layer is brown silt loam about 12 inches thick. The upper 8 inches of the subsoil is brown silt loam, and the lower 40 inches is brown silty clay loam. The underlying material is brown silty clay loam.

About 15 percent of the total acreage is an included Bethany soil. Also included are small areas of Norge soil.

This soil is used mainly for wheat, grain sorghum, and cotton. It is also suited to alfalfa, tame pasture, and native range.

Management is needed to maintain soil structure and fertility. The return of crop residue and the an-

nual application of fertilizer are important in maintaining a high level of fertility on cropland. Capability unit I-1; Loamy Prairie range site; pasture and hayland group 8A.

38—Pond Creek silt loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high. Included in mapping are small areas of Norge and Bethany soils.

In a representative profile the surface layer is dark grayish brown silt loam about 11 inches thick. The upper 23 inches of the subsoil is dark brown silty clay loam and silt loam, and the lower 28 inches is brown silty clay loam.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to alfalfa and tame pasture. A few areas are in native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. The risk of water erosion can be reduced by keeping an adequate cover of crop residue on the surface. Where this cover is not adequate, terraces are needed. Additional fertilization is needed if crop residue is to be returned to the soil or left on the surface. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland group 8A.

39—Port fine sandy loam, overwash. This nearly level soil is on flood plains. It is occasionally flooded for brief periods in spring and fall. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is reddish brown fine sandy loam about 14 inches thick. The next layer is dark brown silt loam about 34 inches thick. The underlying material is reddish brown silt loam.

About 10 percent of the total acreage is an included soil that is similar to the Port soil but has as much as 30 inches of fine sandy loam overwash. Also included are small areas of Yahola and Pulaski soils.

This soil is used mainly for alfalfa, wheat, and grain sorghum. It is also suited to cotton, peanuts, tame pasture, and native range.

Maintaining or improving soil structure and fertility and controlling damaging floods are the main concerns of management. Growing crops that are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Periodically changing the depth of tillage and tilling when the soil is not wet reduce the risk of the formation of a tillage pan. Damage from flooding can be reduced by protective measures in all areas. Watershed projects upstream are needed for flood control. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland group 2A.

40—Port silt loam. This nearly level soil is on flood plains. It is occasionally flooded for brief periods in spring and fall. It is moderately permeable. Available water capacity is high.

In a representative profile the upper 9 inches of the surface layer is reddish brown silt loam, and the lower 18 inches is dark reddish brown silt loam. The subsoil is reddish brown silty clay loam about 15 inches thick. The underlying material is reddish brown silt loam.

About 5 percent of the total acreage is an included

Yahola soil. About 10 percent is an included Cyril soil. This soil is used mainly for alfalfa, wheat, and grain sorghum. It is also suited to cotton, tame pasture, and native range.

Maintaining or improving soil structure and fertility and controlling damaging floods are the main concerns of management. Growing crops that are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Periodically changing the depth of tillage and tilling when the soil is not wet reduce the risk of the formation of a tillage pan. Damage from flooding can be reduced by protective measures in all areas. Watershed projects upstream are needed for flood control. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland group 2A.

41—Pulaski fine sandy loam. This nearly level soil is on flood plains. It is occasionally flooded for brief periods in spring and fall. It is moderately rapidly permeable. Available water capacity is medium.

In a representative profile the surface layer is reddish brown fine sandy loam about 10 inches thick. The underlying material is reddish yellow fine sandy loam.

About 10 percent of the total acreage is an included soil that is similar to the Pulaski soil but has sandier underlying material. Also included are small areas of Yahola soil.

This soil is used mainly for alfalfa, wheat, and grain sorghum. It is also suited to cotton, peanuts, tame pasture, and native range.

Maintaining or improving soil structure and fertility and controlling damaging floods are the main concerns of management. Growing crops that are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Periodically changing the depth of tillage and tilling when the soil is not wet reduce the risk of the formation of a tillage pan. Damage from flooding can be reduced by protective measures in all areas. Watershed projects upstream are needed for flood control. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland group 2A.

42—Quinlan-Rock outcrop complex, 12 to 30 percent slopes. This is a shallow, moderately steep to steep mapping unit on uplands. It is about 60 percent Quinlan soil and 10 percent Rock outcrop. The Quinlan soil is on crests and side slopes. It is moderately rapidly permeable and has low available water capacity. Rock outcrop occurs as bluff faces of broken land and steep breaks.

About 20 percent of the total acreage is an included soil that is similar to the Quinlan soil but is not calcareous. About 10 percent is an included Nash soil.

In a representative profile of the Quinlan soil, the surface layer is reddish brown loam about 8 inches thick. The subsoil is red loam about 6 inches thick. The underlying material is red sandstone. Rock outcrop is red calcareous sandstone.

This unit is used mostly for native range. The quantity and quality of native grasses can be maintained or improved by controlled grazing and by providing protection against fire. For suggested range management, refer to "Range." Capability unit VIIe-2; Shallow Prairie range site; not assigned to a pasture and hayland group.

43—Reinach silt loam. This nearly level soil is on flood plains. It is rarely flooded, but is subject to flooding for very brief periods in spring and fall. This soil is moderately permeable. Available water capacity is high.

In a representative profile the upper 9 inches of the surface layer is brown silt loam, and the lower 21 inches is reddish brown silt loam. The subsoil is red silt loam about 20 inches thick. The underlying material is red very fine sandy loam.

About 30 percent of the total acreage is an included soil that is similar to the Reinach soil but has a thinner surface layer. About 10 percent is an included Dale soil.

This soil is used mainly for cotton, alfalfa, wheat, and grain sorghum. A few areas are in tame pasture and native range.

Maintaining desirable soil structure and fertility are the main concerns of management. Returning a moderate to large amount of crop residue each year and adding supplemental applications of a suitable fertilizer help to maintain desirable soil structure and fertility. Periodically changing the depth of tillage and tilling when the least compaction is likely to occur reduce the risk of the formation of a tillage pan. Capability unit I-2; Loamy Bottomland range site; pasture and hayland group 2A.

44—Renfrow silt loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is very slowly permeable. Available water capacity is medium.

In a representative profile the surface layer is dark brown silt loam about 9 inches thick. The upper 6 inches of the subsoil is reddish brown silty clay loam, the next 11 inches is reddish brown silty clay, and the lower 39 inches is red silty clay. The underlying material is red clayey shale.

About 5 percent of the total acreage is an included Kirkland soil, and about 5 percent is an included Bethany soil. About 10 percent is an included soil that is similar to the Renfrow soil but has a thinner, dark colored surface layer.

This soil is used mainly for wheat and grain sorghum. It is also suited to cotton, tame pasture, and native range.

Controlling water erosion, maintaining desirable soil structure, and overcoming droughtiness are the main concerns of management. The risk of water erosion can be reduced by keeping an adequate cover of crop residue on the surface at seeding time, by terracing, and by farming on the contour. If a large amount of crop residue is to be returned to the soil, fertilization is needed. Capability unit IIIe-1; Claypan Prairie range site; pasture and hayland group 8C.

45—Renfrow silt loam, 2 to 5 percent slopes, eroded. This very gently sloping to gently sloping soil is on uplands. It is very slowly permeable. Available water capacity is medium. This soil is so eroded that on about 20 percent of the acreage the present surface layer is a mixture of material from the original surface layer and the subsoil. Rills and a few shallow gullies have formed in most areas.

In a representative profile the surface layer is reddish brown silt loam about 8 inches thick. The upper 6 inches of the subsoil is reddish brown silty clay loam, the next 36 inches is reddish brown silty clay,

and the lower 13 inches is red silty clay. The underlying material is red clayey shale.

About 10 percent of the total acreage is an included soil that is similar to the Renfrow soil but either has a thinner, dark colored surface layer or lacks the original dark colored surface layer. About 5 percent is an included Bethany soil.

This soil is used mainly for grain sorghum and wheat. Some areas are in tame pasture and native range.

Management is needed to provide protection from rill and gully erosion and to maintain or improve soil tilth and fertility. Terracing, farming on the contour, and returning large amounts of crop residue in cultivated areas improve soil tilth and fertility and reduce the risk of further erosion. Close growing crops and perennial grasses are better suited than row crops. Capability unit IVE-1; Claypan Prairie range site; pasture and hayland group 8C.

46—Renfrow silt loam, 2 to 5 percent slopes, severely eroded. This very gently sloping to gently sloping soil is on uplands. It is very slowly permeable. Available water capacity is medium. This soil is so eroded that further cultivation is impractical. The present surface layer is a mixture of material from the original surface layer and the subsoil. Many gullies have formed, some of which are uncrossable with farm machinery.

In a representative profile the surface layer is reddish brown silt loam about 10 inches thick. The subsoil is red silty clay about 55 inches thick. The underlying material is red shaly clay.

About 30 percent of the total acreage is an included soil that is similar to the Renfrow soil but has a thinner, dark colored surface layer. About 20 percent is an included soil that is similar but has a more loamy subsoil.

This soil is used mainly for native range. A few areas are in tame pasture. For suggested range management, refer to "Range." For suggested tame pasture management and suitable grasses, refer to "Pasture and Hay." Capability unit VIe-7; Eroded Clay range site; pasture and hayland group 8F.

47—Renfrow-Hinkle complex, 1 to 3 percent slopes. This is a deep, very gently sloping mapping unit on uplands. It is about 40 percent Renfrow soil and 25 percent Hinkle soil. The Renfrow soil is on side slopes and foot slopes. The Hinkle soil occurs as irregular, somewhat round areas about $\frac{1}{2}$ acre to 3 acres in size. It is mostly on side slopes, but is also on crests and foot slopes between areas of the Renfrow soil. Both soils are very slowly permeable. Available water capacity is medium in the Renfrow soil and low in the Hinkle soil.

About 10 percent of the total acreage is an included Kirkland soil. About 25 percent is an included Grant soil.

In a representative profile of the Renfrow soil, the surface layer is reddish brown silt loam about 7 inches thick. The upper 5 inches of the subsoil is reddish brown silty clay loam, and the lower 50 inches is red silty clay. The underlying material is red and gray shaly clay.

In a representative profile of the Hinkle soil, the surface layer is reddish brown silt loam about 6 inches

thick. The upper 8 inches of the subsoil is reddish brown silty clay loam, the next 12 inches is red silty clay loam, and the lower 16 inches is light red silty clay loam. The underlying material is red shale.

Most of the acreage is used for wheat and grain sorghum. Some areas are in tame pasture and native range.

Management is needed that improves or maintains soil structure, reduces surface crusting and content of sodium, and controls erosion. An effective practice for reducing the sodium content is adding organic material and gypsum. If such materials are added, however, the soils should not be tilled for at least two growing seasons. Leaving plant residue on the surface provides organic material for improving or maintaining soil structure and fertility. The residue also protects the soils against erosion, reduces surface crusting, and increases the intake of water. Crops respond to fertilization.

Diversion terraces are needed in places to control runoff from higher lying areas. Natural drainageways should be established in perennial vegetation. Capability unit IVs-1; Renfrow soil in Claypan Prairie range site and pasture and hayland group 8C; Hinkle soil in Slickspot range site and pasture and hayland group 8D.

48—Stephenville fine sandy loam, 1 to 3 percent

slopes. This very gently sloping soil is on uplands. It is moderately permeable. Available water capacity is medium.

In a representative profile the surface layer is light brown fine sandy loam about 10 inches thick. The subsoil is reddish brown sandy clay loam about 28 inches thick. The underlying material is red sandstone.

About 10 percent of the total acreage is an included Windthorst soil, and about 5 percent is an included Darnell soil. About 20 percent is an included soil that is similar to the Stephenville soil but is more than 40 inches thick over sandstone.

This soil is used mainly for peanuts, cotton, grain sorghum, and tame pasture. It is also suited to wheat, peanuts, watermelons, alfalfa, and native range (fig. 1).

Management is needed to control erosion and maintain or improve soil fertility and structure. Soil blowing is a hazard if the surface is left bare. A cropping system that provides maximum use of crop residue as a protective cover, a cover crop of legumes following harvest of peanuts, or stubble mulching following harvest of small grain all help to control soil blowing. Terracing and contour farming help to control water erosion. Changing the depth of tillage reduces the risk of the formation of a plowpan. Crops respond well to applications of fertilizer. Capability unit IIe-2; Sandy



Figure 1.—Native grass on Stephenville fine sandy loam, 1 to 3 percent slopes. This field was formerly in cultivated crops.

Savannah range site; pasture and hayland group 8A.

49—Stephenville fine sandy loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. It is moderately permeable. Available water capacity is medium.

In a representative profile the surface layer is brown fine sandy loam about 6 inches thick. The subsurface layer is light brown fine sandy loam about 4 inches thick. The upper 20 inches of the subsoil is reddish brown sandy clay loam, and the lower 8 inches is red sandy clay loam. The underlying material is red soft sandstone.

About 10 percent of the total acreage is an included Windthorst soil. About 20 percent is an included Noble soil, and 5 percent is an included Darnell soil.

This soil is used mainly for grain sorghum and tame pasture. It is also suited to native range, wheat, cotton, peanuts, and watermelons.

Management is needed to control erosion and maintain soil fertility. Effective practices are growing soil improving crops and crops that produce large amounts of residue, stubble mulching, terracing, cultivating on the contour, and using grassed waterways. Capability unit IIIe-4; Sandy Savannah range site; pasture and hayland group 8A.

50—Stephenville fine sandy loam, 2 to 5 percent slopes, eroded. This very gently sloping to gently sloping soil is on uplands. It is moderately permeable. Available water capacity is medium. This soil is so eroded that on about 40 percent of the acreage the present surface layer is a mixture of material from the original surface layer and the upper part of the subsoil. Small rills and some shallow gullies have formed in most areas.

In a representative profile the surface layer is brown fine sandy loam about 8 inches thick. The upper 18 inches of the subsoil is yellowish red sandy clay loam, and the lower 10 inches is red sandy clay loam. The underlying material is red sandstone.

About 5 percent of the total acreage is an included Darnell soil, and about 10 percent is an included Noble soil. About 5 percent is an included soil that is similar to the Stephenville soil but has a thinner surface layer.

This soil is used mainly for tame pasture and native range. It is also suited to grain sorghum, wheat, cotton, and peanuts.

Management is needed to protect the soil against more severe rill and gully erosion and to maintain or improve soil tilth and fertility. Suitable practices are terracing, contour farming, returning crop residue in cultivated areas, and adding adequate amounts of fertilizer. Close growing crops and perennial grasses are better suited than row crops. Capability unit IIIe-5; Sandy Savannah range site; pasture and hayland group 8A.

51—Stephenville fine sandy loam, 2 to 8 percent slopes, severely eroded. This very gently sloping to sloping soil is on uplands. It is moderately permeable. Available water capacity is medium. This soil is so eroded that further cultivation is impractical. The present surface layer is a mixture of material from the original surface layer and the subsoil. Many gullies have formed, some of which are uncrossable with farm machinery.

In a representative profile the surface layer is brown

fine sandy loam about 5 inches thick. The upper 21 inches of the subsoil is reddish brown sandy clay loam, and the lower 10 inches is yellowish red sandy clay loam. The underlying material is red sandstone.

About 20 percent of the total acreage is an included Windthorst soil. Also included are small areas of Darnell soil.

This soil is used mainly for native range, but a few areas are in tame pasture. Because of the many gullies, tame pasture is difficult to establish. The addition of fertilizer is beneficial in establishing a good vegetative cover. For suggested tame pasture management and suitable grasses, refer to "Pasture and Hay." For native range, refer to "Range." Capability unit VIe-4; Eroded Sandy Savannah range site; pasture and hayland group 8F.

52—Stephenville-Darnell complex, 1 to 8 percent slopes. This is a moderately deep and shallow, very gently sloping to sloping mapping unit on uplands. It is about 50 percent Stephenville soil and 25 percent Darnell soil. The Stephenville soil is on lower side slopes and foot slopes. The Darnell soil is on upper side slopes and crests. The Stephenville soil is moderately permeable and has medium available water capacity. The Darnell soil is moderately rapidly permeable and has low available water capacity.

About 10 percent of the total acreage is an included soil that is similar to the Darnell soil but is deeper. About 15 percent is an included Noble soil.

In a representative profile of the Stephenville soil, the surface layer is brown fine sandy loam about 6 inches thick. The subsurface layer is light brown fine sandy loam about 4 inches thick. The upper 24 inches of the subsoil is red sandy clay loam, and the lower 4 inches is red fine sandy loam. The underlying material is red sandstone.

In a representative profile of the Darnell soil, the surface layer is brown fine sandy loam about 5 inches thick. The subsoil is light reddish brown fine sandy loam about 12 inches thick. The underlying material is red sandstone.

Most of the acreage is used for native range or tame pasture. Shallowness over bedrock and strong slopes make these soils unsuitable for cultivation. For suggested tame pasture management, refer to "Pasture and Hay." For native range, refer to "Range." Capability unit VIe-8; Stephenville soil in Sandy Savannah range site and pasture and hayland group 8A; Darnell soil in Shallow Savannah range site and pasture and hayland group 14A.

53—Stephenville-Eufaula complex, 3 to 8 percent slopes. This is a moderately deep and deep, gently sloping to sloping mapping unit on uplands. It is about 35 percent Stephenville soil and 30 percent Eufaula soil. The Stephenville soil is on crests. The Eufaula soil is on foot slopes. The Stephenville soil is moderately permeable and has medium available water capacity. The Eufaula soil is rapidly permeable and has low available water capacity.

About 10 percent of the total acreage is an included soil that is similar to the Eufaula soil but is less than 60 inches deep over sandstone. About 20 percent is an included Dougherty soil.

In a representative profile of the Stephenville soil, the surface layer is grayish brown loamy fine sand

about 8 inches thick. The subsurface layer is light brown loamy fine sand about 6 inches thick. The upper 8 inches of the subsoil is yellowish red sandy clay loam, and the lower 8 inches is red fine sandy loam. The underlying material is light red sandstone.

In a representative profile of the Eufaula soil, the surface layer is grayish brown loamy fine sand about 10 inches thick. The subsurface layer is very pale brown fine sand about 24 inches thick. Below this is pink fine sand containing bands of reddish brown loamy fine sand that average 1 inch thick and are 1 to 4 inches apart.

Most of the acreage is used for tame pasture and native range. Management is needed to keep a cover on the soil at all times to help control soil blowing. Lovegrass is well suited in areas used for tame pasture. For suggested tame pasture management and suitable plants, refer to "Pasture and Hay." For range, refer to "Range." Capability unit VIe-2; Deep Sand Savannah range site; Stephenville soil in pasture and hayland group 9A and Eufaula soil in group 9B.

54—Stephenville-Pulaski complex, 0 to 12 percent slopes. This is a moderately deep and deep, nearly level to strongly sloping mapping unit. It is about 55 percent Stephenville soil and 25 percent Pulaski soil. The Stephenville soil is on uplands. The Pulaski soil is on bottom land. The Stephenville soil is moderately permeable, and the Pulaski soil is moderately rapidly permeable. Available water capacity for both is medium. About 20 percent of the total acreage is an included Noble fine sandy loam on uplands.

In a representative profile of the Stephenville soil, the surface layer is reddish brown fine sandy loam about 6 inches thick. The subsurface layer is light reddish brown fine sandy loam about 5 inches thick. The upper 24 inches of the subsoil is reddish brown sandy clay loam, and the lower 3 inches is red sandy clay loam. The underlying material is red sandstone.

In a representative profile of the Pulaski soil, the surface layer is reddish brown fine sandy loam about 12 inches thick. The underlying material is reddish yellow fine sandy loam.

Most of the acreage is used for native range and tame pasture. Strong slopes and frequent flooding make these soils unsuitable for cultivation. Controlling brush and providing protection against fire are suitable practices for increasing the quantity of grasses. For suggested range management, refer to "Range." Capability unit VIe-9; Stephenville soil in Sandy Savannah range site and pasture and hayland group 8A; Pulaski soil in Loamy Bottomland range site and pasture and hayland group 2A.

55—Teller loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the upper 9 inches of the surface layer is brown loam, and the lower 7 inches is dark brown loam. The upper 16 inches of the subsoil is brown clay loam, the next 14 inches is reddish brown sandy clay loam, and the lower 16 inches is yellowish red fine sandy loam. The underlying material is yellowish red fine sandy loam.

About 10 percent of the total acreage is an included Norge soil. About 20 percent is an included soil that is

similar to the Teller soil but has a surface layer of fine sandy loam.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to peanuts, alfalfa, and tame pasture. A small acreage is in native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Water erosion can be controlled by keeping an adequate cover of crop residue on the surface. Where this cover is not adequate, terraces are needed. Additional fertilization is needed if crop residue is to be returned to the soil or left on the surface. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland group 8A.

56—Teller loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high.

In a representative profile the surface layer is brown loam about 6 inches thick. The upper 6 inches of the subsoil is reddish brown loam, the next 28 inches is reddish brown sandy clay loam, and the lower 22 inches is red fine sandy loam. The underlying material is red fine sandy loam.

About 20 percent of the total acreage is an included soil that is similar to the Teller soil but has a thinner, dark colored surface layer. About 5 percent is an included Norge soil.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to tame pasture, peanuts, and native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Runoff and erosion can be reduced by installing terraces and by farming on the contour. The terraces can be more widely spaced if adequate conservation practices are used. Maintaining an adequate cover of crop residue on the surface at seeding time also helps to control water erosion. Applications of fertilizer are needed if a large amount of crop residue is to be returned to the soil or left on the surface. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland group 8A.

57—Teller loam, 2 to 5 percent slopes, eroded. This very gently sloping to gently sloping soil is on uplands. It is moderately permeable. Available water capacity is high. This soil is so eroded that on about 25 percent of the acreage the present surface layer is a mixture of material from the original surface layer and the upper part of the subsoil. Small rills and a few shallow gullies have formed in most areas. Included areas of Norge soils make up about 15 percent of the total acreage.

In a representative profile the surface layer is reddish brown loam about 8 inches thick. The upper 34 inches of the subsoil is reddish brown sandy clay loam, and the lower 20 inches is light reddish brown fine sandy loam. The underlying material is yellowish red fine sandy loam.

This soil is used mostly for grain sorghum, tame pasture, and native range. It is also suited to wheat and cotton.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Terraces can be used to control water erosion. They can be more widely spaced if the soil surface is protected by a cover of crop residue. Fertiliza-

tion is needed to maintain soil fertility. It also helps crops to produce the residue needed to protect the soil against erosion. Capability unit IIIe-3; Loamy Prairie range site; pasture and hayland group 8A.

58—Teller loam, 5 to 8 percent slopes. This sloping soil is on uplands. It is moderately permeable. Available water capacity is high. About 15 percent of the total acreage is an included soil that is similar but has a surface layer of sandy clay loam.

In a representative profile the surface layer is reddish brown loam about 8 inches thick. The upper 37 inches of the subsoil is red sandy clay loam, and the lower 20 inches is red fine sandy loam. The underlying material is red fine sandy loam.

This soil is used mainly for tame pasture and native range. Bermudagrass and lovegrass are the main pasture plants. This soil is also suited to wheat and grain sorghum.

Management is needed to control water erosion and maintain or improve soil structure. Growing crops that produce large amounts of residue and returning all residue protect the soil from erosion and reduce crusting. A suitable cropping system that reduces runoff and maintains or improves soil structure is one of row crops followed by cover crops in winter. Other practices that reduce runoff are terracing, tilling on the contour, and using grassed waterways. For suggested tame pasture management, refer to "Pasture and Hay." For range, refer to "Range." Capability unit IVe-2; Loamy Prairie range site; pasture and hayland group 8A.

59—Tivoli loamy fine sand. This sloping to strongly sloping soil is on uplands. It is rapidly permeable. Available water capacity is low. About 40 percent of the total acreage is an included soil that is similar but is calcareous within a depth of 40 inches.

In a representative profile the surface layer is brown loamy fine sand and about 10 inches thick. The upper 30 inches of the underlying material is light brown fine sand. The lower part of the underlying material is pink fine sand.

This soil is used mainly for native range. The quantity and quality of native grasses can be maintained or improved by controlling grazing. For suggested range management, refer to "Range." Capability unit VIIe-3; Dune range site; not assigned to a pasture and hayland group.

60—Windthorst fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is medium.

In a representative profile the surface layer is grayish brown fine sandy loam about 4 inches thick. The subsurface layer is light brown fine sandy loam about 6 inches thick. The upper 9 inches of the subsoil is reddish brown clay, the next 27 inches is reddish yellow and red clay, and the lower 6 inches is coarsely mottled red, yellowish red, and reddish yellow clay loam. The underlying material is stratified sandstone and shale.

About 20 percent of the total acreage is an included Stephenville soil. About 10 percent is an included soil that is similar to the Windthorst soil but has bedrock at a depth of less than 40 inches.

This soil is used mainly for cotton, grain sorghum,

and tame pasture. It is also suited to peanuts, native range, and wheat.

Management is needed to control erosion and maintain or improve soil fertility and structure. Soil blowing is a hazard if the surface is left bare. A cropping system that provides maximum use of crop residue as a protective cover, a cover crop of legumes following harvest of peanuts, or stubble mulching following harvest of small grain all help to control soil blowing. Terracing and contour farming help to control water erosion. Changing the depth of tillage reduces the risk of the formation of a plowpan. Crops respond well to applications of fertilizer. Capability unit IIe-2; Sandy Savannah range site; pasture and hayland group 8A.

61—Windthorst fine sandy loam, 2 to 5 percent slopes, eroded. This very gently sloping to gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is medium. This soil is so eroded that on most of the acreage the plow layer is a mixture of material from the original surface layer and the upper part of the subsoil. Small rills and some shallow gullies have formed in most areas.

In a representative profile the surface layer is light brown fine sandy loam about 4 inches thick. The upper 22 inches of the subsoil is reddish brown and red sandy clay and clay, the next 12 inches is yellowish red sandy clay, and the lower 4 inches is red clay loam. The underlying material is rippable, red shale stratified with sandstone.

About 10 percent of the total acreage is an included Stephenville soil. About 10 percent is an included soil that is similar to the Windthorst soil but is between 30 and 40 inches deep over bedrock.

This soil is used mainly for tame pasture and native range. It is also suited to grain sorghum, wheat, cotton, and peanuts.

Management is needed to protect the soil against more severe rill and gully erosion and to maintain or improve soil tilth and fertility. Suitable practices in cultivated areas are terracing, contour farming, returning crop residue, and adding adequate amounts of a complete fertilizer. Close growing crops and perennial grasses are better suited than row crops. For suggested tame pasture management, refer to "Pasture and Hay." For range, refer to "Range." Capability unit IIIe-5; Sandy Savannah range site; pasture and hayland group 8A.

62—Yahola fine sandy loam. This nearly level soil is on flood plains. It is occasionally flooded for only brief periods in spring and fall. It is moderately rapidly permeable. Available water capacity is medium.

In a representative profile the surface layer is reddish brown fine sandy loam about 10 inches thick. The underlying material is reddish brown and light reddish brown, stratified fine sandy loam.

About 40 percent of the total acreage is an included soil that is similar to the Yahola soil but is not calcareous throughout. Also included are small areas of Gracemont and Pulaski soils.

This soil is used mainly for alfalfa, wheat, and grain sorghum. It is also suited to cotton, peanuts, tame pasture, and native range.

Maintaining or improving soil structure and fertility and controlling damaging floods (fig. 2) are the main concerns of management. Growing crops that



Figure 2.—Flooding on Yahola fine sandy loam.

are high in residue, returning the residue to the soil, and adding fertilizer help to maintain soil structure and fertility. Periodically changing the depth of tillage and tilling when the soil is not wet reduce the risk of the formation of a tillage pan. Damage from flooding can be reduced by protective measures in all areas. Watershed projects upstream are needed for flood control. Capability unit IIw-1; Loamy Bottomland range site; pasture and hayland group 2A.

63—Zaneis loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high.

In a representative profile (fig. 3) the surface layer is dark brown loam about 13 inches thick. The upper 31 inches of the subsoil is reddish brown and red clay loam, and the lower 6 inches is red sandy clay loam. The underlying material is red and light gray sandstone and shale.

Included with this soil in mapping are small areas of soils that are similar to the Zaneis soil but are less than 40 inches deep over sandstone. Also included are small areas of Teller and Grant soils.

This soil is used mainly for cotton, wheat, and grain sorghum. It is also suited to alfalfa and tame pasture. A few areas are in native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of

management. Keeping an adequate cover of crop residue on the surface helps to control erosion. Where this cover is not adequate, terraces are needed. Additional fertilization is needed if crop residue is to be returned to the soil or left on the surface. Capability unit IIe-1; Loamy Prairie range site; pasture and hayland group 8A.

64—Zaneis loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high.

In a representative profile the surface layer is dark brown loam about 11 inches thick. The upper 6 inches of the subsoil is reddish brown clay loam, and the lower 28 inches is red clay loam. The underlying material is red, soft sandstone and shale.

About 10 percent of the total acreage is an included soil that is similar to the Zaneis soil but has a thinner, dark colored surface layer. About 10 percent is an included soil that is similar but is less than 40 inches deep over bedrock. About 15 percent is an included Grant soil.

This soil is used mainly for cotton, grain sorghum, and wheat. The rest of the acreage is in tame pasture and native range.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Runoff and erosion can be reduced by



Figure 3.—Profile of Zaneis loam.

installing terraces and by farming on the contour. The terraces can be more widely spaced if adequate conservation practices are used. Maintaining an adequate cover of crop residue on the surface at seeding time also helps to control water erosion. Applications of fertilizer are needed if a large amount of crop residue is to be returned to the soil or left on the surface. Capability unit IIIe-2; Loamy Prairie range site; pasture and hayland group 8A.

65—Zaneis loam, 2 to 5 percent slopes, eroded. This gently sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high. This soil is so eroded that in about 25 percent of the acreage the present surface layer is a mixture of material from the original surface layer and the upper part of the subsoil. Small rills and a few shallow gullies have formed in most areas.

In a representative profile the surface layer is dark brown loam about 8 inches thick. The upper 16 inches of the subsoil is reddish brown clay loam, and the lower 18 inches is red clay loam. The underlying material is red soft sandstone and shale.

About 5 percent of the total acreage is an included Teller soil, and about 20 percent is an included Grant soil. About 10 percent is an included soil that is similar to the Zaneis soil but is less than 40 inches deep over bedrock.

This soil is used mostly for grain sorghum, tame pasture, and native range. It is also suited to wheat and cotton.

Controlling water erosion and maintaining desirable soil structure and fertility are the main concerns of management. Terraces can be used to control water erosion. They can be more widely spaced if the surface is protected by a cover crop of residue. Fertilization is needed to maintain soil fertility. It also helps crops to produce the residue needed to protect the soil against erosion. Capability unit IIIe-3; Loamy Prairie range site; pasture and hayland group 8A.

66—Zaneis loam, 2 to 8 percent slopes, severely eroded. This very gently sloping to sloping soil is on uplands. It is moderately slowly permeable. Available water capacity is high. This soil is so eroded that further cultivation is impractical. The present surface layer is a mixture of material from the original surface layer and the subsoil. Many gullies have formed, some of which are uncrossable with farm machinery.

In a representative profile the surface layer is reddish brown loam about 5 inches thick. The upper 7 inches of the subsoil is reddish brown clay loam, the next 24 inches is yellowish red clay loam, and the lower 9 inches is reddish brown fine sandy loam. The underlying material is red sandstone.

About 15 percent of the total acreage is an included soil that is similar to the Zaneis soil but has a thinner surface layer. About 15 percent is an included soil that is similar but has a clayey subsoil.

This soil is used mainly for native range, but a few areas are in tame pasture. Tame pasture is difficult to establish because of deep gullies. Large amounts of fertilizer are beneficial in establishing a good vegetative cover. For suggested tame pasture management and suitable grasses, refer to "Pasture and Hay." For native range, refer to "Range." Capability unit VIe-10; Eroded Prairie range site; pasture and hayland group 8F.

Planning the Use and Management of the Soils¹

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to plan the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment, and to help avoid soil-related failures in uses of the land.

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating to the kinds of soil and their

¹ THEODORE LEHMAN, conservation agronomist, Soil Conservation Service, helped prepare this section.

productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, range, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and the costly failures in homes and other structures resulting from unfavorable soil properties may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Crops

The major management concerns when using the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the predicted yields of the main crops, hay, and pasture are presented for each soil.

This section provides information about the overall agricultural potential and needed practices in the survey area for those in the agribusiness sector—equipment dealers, drainage contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil Maps for Detailed Planning." When making plans for management systems for individual fields or farms, check the detailed information given in the description of each soil.

The information in the paragraphs that follow can be used with that in the description of the mapping units to help the land user select appropriate practices

for specific soils. Most good management practices accomplish more than one purpose and can be used on nearly all of the cropland in the county.

Cultivated soils need management that conserves moisture, controls erosion, maintains soil fertility and structure, supplies organic matter, and preserves good tilth. For suggested combinations of practices for specific soils, see "Soil Maps For Detailed Planning."

Soil erosion is the major soil problem on the cropland in Grady County. If the slope is more than 2 percent, erosion is a hazard. Grant, Minco, Nash, Norge, Renfrow, and Teller soils, for example, have slopes of 2 percent or more.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils having a clayey subsoil, such as the Kirkland and Renfrow soils. Erosion has also reduced productivity on soils that tend to be droughty, such as Hinkle soils. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves quality of water for municipal use, for recreation, and for fish and wildlife.

In many sloping fields, preparing a good seedbed and tilling are difficult on clayey or hardpan spots because the original friable surface soil has been eroded away. Such spots are common in areas of the eroded Renfrow soils.

Erosion-control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land and also provide nitrogen and improve tilth for the following crop.

Slopes are so sandy and irregular that contour tillage or terracing is not practical in most areas of the sloping Dougherty soils. On these soils, cropping systems that provide substantial vegetative cover are required to control erosion unless minimum tillage is practiced. Minimizing tillage and leaving crop residues on the surface help to increase infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey area but are more difficult to use successfully on the soils that have a clayey surface layer.

Terraces and diversions reduce the length of slope and reduce runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. Grant soils and Pond Creek soils are suitable for terraces. Some soils are less suitable for terraces and diversions because of irregular slopes, a clayey subsoil which would be exposed in terrace channels, or bedrock at a depth of less than 40 inches.

Contouring and contour stripcropping are suitable erosion-control practices in the survey area. They are best adapted to soils having smooth, uniform slopes, including most areas of the sloping Grant, Minco, Norge, Pond Creek, and Teller soils.

Soil blowing is a hazard on the sandy Konawa and Dougherty soils. Soil blowing can damage these soils

in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or rough surfaces through proper tillage minimizes soil blowing on these soils.

The increase in crop yields in recent years indicates that effective measures for controlling erosion have been applied. Suitable practices for helping to control erosion are growing a winter cover crop; using a cropping system whereby crop residue is returned to the soil; stubble mulching; farming on the contour; sowing grass in waterways; and applying plant food. Control of insects and plant diseases is also needed. On soils subject to water erosion, terraces are needed to keep soil loss within acceptable limits.

Minimum tillage is needed where soils are cropped. Tillage is needed to prepare a seedbed, to control weeds, and to provide a suitable place for the growth of plant roots. Excessive tillage breaks down the soil structure and speeds up the decomposition of organic material. The soils then tend to puddle and crust on the surface and take in less water and air. Thus, less moisture is stored for plant growth.

Minimum tillage reduces the amount of fieldwork essential in preparing the seedbed, in planting, and in cultivating. Approved herbicides instead of cultivation can be used for weed control. A cropping system that includes perennial grasses or legumes is an excellent way to improve the physical condition of the soil.

Crop residue management is needed to maintain soil structure and to aid in maintaining soil fertility and controlling erosion. When wind erosion is a problem, protective amounts of crop residue should be left on the surface or worked partly into the surface. Crop residue supplies organic matter or humus that improves soil structure and soil tilth, reduces the hazard of erosion, and helps prevent crusting. Soil-maintaining crops, wheat for example, produce large amounts of residue. This residue and additional plant food are needed to maintain soil fertility.

Pasture and hay

Tame pasture makes up about 20 percent of the acreage in Grady County. Weeping lovegrass is one of the dominant grasses seeded, especially on the more sandy soils in the southern half of the county. Bermudagrass is used throughout the county. Fescue is seeded on wet soils. Alkali sacaton is suited to saline soils. King Ranch and Caucasian bluestems are suited to the well-drained, deep upland soils that have a loamy or clayey subsoil. Most pastures are grazed throughout the year. Native grass is available on some farms.

Improved management is chiefly proper seeding rates and appropriate planting dates; control of weeds, insects, and plant diseases; and application of fertilizer according to results of tests and desired production.

In planning for tame pasture it is important to consider the kinds of soils and the season during which additional forage is needed. Selecting the best legumes to be seeded with the base grasses is important.

Application of fertilizer and control of grazing are important in maintaining productive pasture. Adequate watering facilities should be provided. Salting

locations and feeding areas should be located to prevent the concentration of livestock on erodible soils.

Pasture and hay suitability groups

The soils of Grady County are grouped according to their suitability as pasture and hayland. Each group is made up of soils that are suitable for the same kind of pasture species, need similar management, and have about the same potential productivity. The groups are described on the pages that follow. Also mentioned are important characteristics of the soils, the names of some of the principal pasture grasses, and estimated yields. Grazing capacities are estimated in terms of animal-unit-months. An animal-unit-month (AUM) is the amount of forage or feed required for one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

GROUP 1A

In this group are deep, clayey, nearly level, very slowly permeable soils on flood plains. They are subject to flooding. They are high in natural fertility. Adequate fertilization, brush control, and prevention of surface compaction are the chief management needs.

Suitable grasses are bermudagrass, fescue, Caucasian bluestem, and alkali sacaton. The grazing season for bermudagrass and Caucasian bluestem is May through October. The better yield of fescue is from December 1 to May 31. Estimated yields per acre are 5.5 animal-unit-months and 2.4 tons of hay.

GROUP 2A

In this group are deep, loamy, nearly level to very gently sloping soils on flood plains. They are subject to flooding. Natural fertility is high. Permeability is moderately rapid to slow.

Suitable grasses are bermudagrass and lovegrass. Estimated average yields per acre are 4 to 8 animal-unit-months and 1.6 to 3.7 tons of hay, depending on the level of fertility maintained.

GROUP 2B

In this group are deep, loamy, nearly level, moderately rapidly permeable soils on flood plains. These soils are wet and are subject to flooding. The water table is within 3 feet of the surface for more than 6 months of the year. Brush control, adequate fertilization, prevention of surface compaction, and surface drainage are the chief management needs.

Bermudagrass and tall fescue are well suited. Estimated average yields per acre are 8 animal-unit-months and 2.4 tons of bermudagrass hay and 9 animal-unit-months and 3.7 tons of fescue hay. Bermudagrass is grazed from May to November, and fescue from December through May.

GROUP 3B

In this group are deep, sandy, nearly level, moderately rapidly permeable soils on flood plains. These soils have a high water table and are subject to flooding. Controlling brush is essential. Small but frequent applications of nitrogen are needed.

Tall fescue grows well on these soils. Bermudagrass is well suited, but production is somewhat lower than on some of the less permeable soils. Estimated yields

per acre are 9 animal-unit-months of tall fescue and 7 animal-unit-months of bermudagrass.

GROUP 8A

In this group are deep and moderately deep, loamy, nearly level to steep soils on uplands. They are high in natural fertility and respond well to fertilization. Permeability is moderately rapid to slow.

Bermudagrass, lovegrass, and King Ranch bluestem are well suited. Estimated yields per acre are 6.0 animal-unit-months of bermudagrass and bluestem, 7.5 animal-unit-months of lovegrass, and 3.1 tons of hay.

GROUP 8C

In this group are deep, loamy, nearly level to gently sloping, very slowly permeable soils on uplands. These soils are somewhat droughty. Adequate fertilization and reduction of surface compaction are the chief management needs.

Bermudagrass and King Ranch, plains, and Caucasian bluestem are well suited. Production is best in spring or early in summer. Estimated yields per acre are 4.0 animal-unit-months and 2.5 tons of hay.

GROUP 8D

In this group are deep, loamy, very gently sloping, very slowly permeable soils on uplands. They are identified as slickspots. They are high in sodium. Droughtiness and low fertility are problems. Management includes good seedbed preparation, additions of gypsum, and adequate fertilization.

Suitable grasses are tall wheatgrass, alkali sacaton, and bermudagrass. Estimated average yields per acre are 2 animal-unit-months and 0.8 ton of hay.

GROUP 8F

In this group are deep and moderately deep loamy soils that are very gently sloping to sloping, moderately permeable to very slowly permeable, and severely eroded. They are on uplands. They are low in natural fertility and respond favorably to applications of fertilizer. Brush control is needed on the sandy soils. Gully shaping is needed in some areas.

Bermudagrass, weeping lovegrass, King Ranch bluestem, and sericea lespedeza are well suited. The estimated average yield per acre is 4 animal-unit-months.

GROUP 9A

In this group are deep and moderately deep, nearly level to moderately steep, moderately permeable sandy soils on uplands. They are low in fertility and respond well to high levels of fertilization. When large amounts of nitrogen are used, split applications are suggested. In addition to adequate fertilization, brush control and lime are needed.

Bermudagrass and lovegrass are well suited. Estimated yields per acre are 4 animal-unit-months of bermudagrass and 5 animal-unit-months of lovegrass.

GROUP 9B

In this group are deep, gently sloping to moderately steep, rapidly permeable sandy soils on uplands. They are low in fertility and available water capacity. They respond favorably to high levels of fertilization. Nitrogen should be applied frequently in small amounts. In

addition to adequate fertilization, brush control and lime are needed.

Bermudagrass and lovegrass are suited. Estimated yields per acre are 4.5 animal-unit-months of lovegrass and 3.5 animal-unit-months of bermudagrass.

GROUP 14A

In this group are shallow, loamy, very gently sloping to moderately steep, moderately rapidly permeable soils on uplands. They are low in natural fertility and available water capacity. The cost of establishing pastures and maintaining production is high and should be compared with expected returns.

Lovegrass is well suited. The estimated average yield per acre is 4 animal-unit-months.

Yields

The per acre average yields that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in table 2 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to or not commonly grown on the soil or that irrigation of a given crop is not commonly practiced on the soil.

The predicted yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management practices used by many farmers in the county are assumed in predicting the yields. Hay and pasture yields are predicted for varieties of grasses and legumes suited to the soil. A few farmers may be using more advanced practices and are obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends upon the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvest of crops with the smallest possible loss; and timeliness of all fieldwork.

The predicted yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase in the future as new production technology is developed. The productivity of a given soil compared to that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but because their acreage is small, predicted yields for these crops are not included. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide informa-

TABLE 2.—*Estimated acre yields of crops and pasture plants*

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Wheat	Grain sorghum	Cotton	Peanuts	Watermelons	Alfalfa	Improved bermuda-grass
	Bu	Bu	Lb	Lb	Ton	Ton	AUM ¹
Amber: 1 -----	30	45	450	1,600		3.5	7.5
Bethany: 2 -----	35	50	450			3.5	7.0
Cyril: 3 -----	30	45	425	1,600		3.5	7.5
Dale: 4 -----	35	50	500			5.0	8.5
Darnell: 5 -----							
Dougherty: 6 ----- 7 -----	15 15	20		1,000	12 10		4.0 3.5
Eufaula: 8 ----- 9 -----							3.5 3.5
Gracemont: 10 -----	25	35	350			3.5	8.0
Gracemore: 11 -----							7.0
Grant: 12 ----- 13 ----- 14 ----- 15 -----	30 25 20	45 40 30	400 325 275			2.5 2.0	7.0 6.5 5.0 5.0
Keokuk: 16 -----	35	50	500	1,700		5.0	8.5
Kirkland: 17 -----	30	40	400				5.5
Konawa: 18 ----- 19 -----	25	40	350	1,300	18	2.6	6.0 4.5
Lela: 20 -----	30	50	450			3.5	5.5
Lucien: 21 -----							4.5
McLain: 22 -----	35	50	500			4.5	7.0
Minco: 23 ----- 24 ----- 25 ----- 26 ----- 27 -----	25 35 30 25	35 50 45 40	500 500 450 400	1,700 1,600 1,500		4.0 3.5	6.5 4.5 8.0 7.5 7.0
Nash: 28 ----- 29 ----- 30 -----	20 20 30	30 30	275				5.0 4.5 4.0

TABLE 2.—*Estimated acre yields of crops and pasture plants—Continued*

Soil name and map symbol	Wheat	Grain sorghum	Cotton	Peanuts	Watermelons	Alfalfa	Improved bermuda-grass
	Bu	Bu	Lb	Lb	Ton	Ton	AUM ¹
Noble:							
31 -----	25	45	350	1,500	15	3.0	6.0
a 32 -----	20	30	275	1,000			5.0
Norge:							
33 -----	35	55	450			3.5	7.5
34 -----	30	45	400			3.0	7.0
35 -----	20	35	300				5.5
Pocasset:							
36 -----	30	45	425			3.5	7.5
Pond Creek:							
37 -----	35	55	450			3.5	7.5
38 -----	30	45	400			3.0	7.0
Port:							
39 -----	35	50	500	1,700		5.0	8.5
40 -----	35	50	500			5.0	8.5
Pulaski:							
41 -----	30	45	425	1,600		3.5	7.5
Quinlan:							
a 42 -----							
Reinach:							
43 -----	35	50	500			5.0	8.5
Renfrow:							
44 -----	25	30	250				3.0
45 -----	15	25					2.5
46 -----							2.0
a 47 -----	20	25					2.5
Stephenville:							
48 -----	30	45	350	1,500	14	2.8	6.0
49 -----	25	35	300	1,300	18		5.5
50 -----	20	30	250	1,000			5.0
51 -----							4.0
52 -----							4.0
53 -----							4.0
54 -----							5.0
Teller:							
55 -----	30	45	400	1,500		3.0	7.0
56 -----	25	40	350	1,300			6.5
57 -----	20	35	300				5.5
58 -----	20	30					6.0
Tivoli:							
59 -----							
Windthorst:							
60 -----	25	45	350	1,200			6.0
61 -----	20	30	250	1,000			5.0
Yahola:							
62 -----	30	45	425	1,500		3.5	7.5
Zaneis:							
63 -----	30	45	400			2.5	7.0
64 -----	25	40	350				6.5
65 -----	20	30	275				5.0
66 -----							4.0

¹ Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

² This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

tion about the productivity and management concerns of the soils for these crops.

Capability Classes and Subclasses

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. This classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.
- Class VI soils have severe limitations that make them generally unsuitable for cultivation.
- Class VII soils have very severe limitations that make them unsuitable for cultivation.
- Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production. No class VIII soils in this county.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty or stony; and *c* used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry. No subclass *c* in this county.

In class I there are no subclasses, because the soils

of this class have few limitations. Class V contains only the subclasses indicated by *w*, *s*, or *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, range, woodland, wildlife habitat, or recreation.

Some of the soils that are well suited to crops and pasture, for example, some soils in capability classes I and II, are now used for range or other low intensity uses.

The capability unit is identified in the description of each soil mapping unit in the section "Soil Maps for Detailed Planning." Capability units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-2.

Range²

About 43 percent of Grady County is native range. Breeding and raising beef cattle is the major livestock enterprise. Range is commonly grazed the year around, and the forage is supplemented with protein and hay.

Where climate and topography are about the same, differences in the kind and amount of vegetation that the range can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 3 shows, for each kind of soil, the name of the range site, the potential annual production of herbage in favorable, normal, and unfavorable years, and the names of major plant species and the percentage of each in the composition of the potential plant community.

A range site supports a distinctive potential plant community, or combination of plants, that can grow on a site that has not undergone major disturbances. Soils that produce the same kind, amount, and proportion of range plants are grouped into range sites. Range sites can be interpreted directly from the soil map where the relationships between soils and vegetation have been correlated. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on range plants and their productivity. Soil reaction, salt content, and a seasonal high water table are also important.

Potential production refers to the amount of herbage that can be expected to grow on well managed range that is supporting the potential plant community. It is expressed in pounds per acre of air-dry herbage for favorable, normal, and unfavorable years. A favorable year is one in which the amount and distribution of precipitation and the temperatures result in growing conditions substantially better than average; a normal year is one in which these conditions are about average for the area; an unfavorable year is

²DARWIN HEDGES, range conservationist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Composition of the potential native plant community on rangeland*

[Soils not listed are not in range sites; such sites can be used for grazing if grass cover is established]

Soil name and map symbol	Range site name	Potential production		Common plant
		Kind of year	Dry Weight	
Amber: 1	Loamy Bottomland	Favorable Normal Unfavorable	Lbs/ac 8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Compassplant Sedges Other trees Heath aster
Bethany: 2	Loamy Prairie	Favorable Normal Unfavorable	5,000 3,500 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Side-oats grama Blue grama Tall dropseed Dotted gayfeather Other trees Other perennial forbs
Cyril: 3	Loamy Bottomland	Favorable Normal Unfavorable	8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Compassplant Heath aster Sedges Other trees
Dale: 4	Loamy Bottomland	Favorable Normal Unfavorable	8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Compassplant Heath aster Sedges Other trees

Darnell:

¹⁵
Darnell part

Shallow Savannah

Favorable
Normal
Unfavorable

3,200
2,100
1,400

Little bluestem
Big bluestem
Yellow Indiangrass
Switchgrass
Side-oats grama
Purpletop
Scribner panicum
Tall dropseed
Hairy sunflower
Other trees
Other shrubs

Noble part

Sandy Savannah

Favorable
Normal
Unfavorable

4,500
3,300
2,500

Little bluestem
Big bluestem
Yellow Indiangrass
Switchgrass
Perennial sunflower
Other perennial grasses
Other trees
Other shrubs
Other perennial forbs

Dougherty:

⁶

Deep Sand Savannah

Favorable
Normal
Unfavorable

4,000
2,800
2,000

Little bluestem
Big bluestem
Sand bluestem
Yellow Indiangrass
Switchgrass
Purpletop
Arrowfeather three-awn
Scribner panicum
Side-oats grama
Perennial lespedeza
Other trees

¹⁷

Dougherty part

Deep Sand Savannah

Favorable
Normal
Unfavorable

4,000
2,800
2,000

Little bluestem
Big bluestem
Sand bluestem
Yellow Indiangrass
Switchgrass
Purpletop
Arrowfeather three-awn
Scribner panicum
Side-oats grama
Perennial lespedeza
Other trees

Eufaula part

Deep Sand Savannah

Favorable
Normal
Unfavorable

4,000
2,800
2,000

Little bluestem
Big bluestem
Sand bluestem
Yellow Indiangrass
Switchgrass
Purpletop
Arrowfeather three-awn
Scribner panicum
Side-oats grama
Perennial lespedeza
Other trees

TABLE 3.—*Composition of the potential native plant community on rangeland—Continued*

Soil name and map symbol	Range site name	Potential production		Common plant
		Kind of year	Dry Weight	
Enfaula: 8	Deep Sand Savannah	Favorable Normal Unfavorable	Lbs/ac 4,000 2,800 2,000	Little bluestem
				Big bluestem
				Sand bluestem
				Yellow Indiangrass
¹⁹ Enfaula part	Deep Sand Savannah	Favorable Normal Unfavorable	4,000 2,800 2,000	Switchgrass
				Purpletop
				Arrowfeather three-awn
				Scribner panicum
				Side-oats grama
				Perennial lespedeza
				Other trees
				Little bluestem
				Big bluestem
				Sand bluestem
Stephenville part	Deep Sand Savannah	Favorable Normal Unfavorable	4,000 2,800 2,000	Yellow Indiangrass
				Switchgrass
				Purpletop
				Arrowfeather three-awn
				Scribner panicum
				Side-oats grama
				Perennial lespedeza
				Other trees
				Little bluestem
				Big bluestem
Gracemont: 10	Subirrigated	Favorable Normal Unfavorable	9,500 7,100 5,500	Yellow Indiangrass
				Switchgrass
				Big bluestem
				Eastern gamagrass
				Canada wildrye
				Maximilian sunflower
				Other perennial grasses

Gracemore: 11	Subirrigated	Favorable Normal Unfavorable	Switchgrass	9,500	
			Big bluestem	7,100	
Grant: 12, 13, 14	Loamy Prairie	Favorable Normal Unfavorable	Yellow Indiangrass	5,500	
			Eastern gamagrass		
			Beaked panicum		
			Canada wildrye		
			Scribner panicum		
			Purpletop		
			Maximilian sunflower		
			Other trees		
			Little bluestem	5,500	
			Big bluestem	3,700	
15: Grant part	Loamy Prairie	Favorable Normal Unfavorable	Yellow Indiangrass	2,500	
			Switchgrass		
			Canada wildrye		
			Side-oats grama		
			Blue grama		
			Tall dropseed		
			Dotted gayfeather		
			Other perennial forbs		
			Other trees		
			Little bluestem	5,500	
Port part	Loamy Bottomland	Favorable Normal Unfavorable	Big bluestem	3,700	
			Yellow Indiangrass	2,500	
			Switchgrass		
			Little bluestem		
			Eastern gamagrass		
			Tall dropseed		
			Beaked panicum		
			Compassplant		
			Heath aster		
			Sedges		
Keokuk: 16	Loamy Bottomland	Favorable Normal Unfavorable	Other trees		
			Big bluestem	8,500	
			Yellow Indiangrass	6,100	
			Switchgrass	4,500	
			Little bluestem		
			Eastern gamagrass		
			Tall dropseed		
			Beaked panicum		
			Compassplant		
			Heath aster		
			Sedges		
			Other trees		

TABLE 3.—*Composition of the potential native plant community on rangeland—Continued*

Soil name and map symbol	Range site name	Potential production		Common plant
		Kind of year	Dry Weight	
Kirkland: 17	Claypan Prairie -----	Favorable Normal Unfavorable	Lbs/ac 4,000 2,800 2,000	Little bluestem -----
				Big bluestem -----
Konawa: 18	Deep Sand Savannah -----	Favorable Normal Unfavorable	4,000 2,800 2,800	Switchgrass -----
				Yellow Indiangrass -----
				Side-oats grama -----
				Blue grama -----
				Buffalograss -----
				Goldenrod -----
				Coralberry -----
				Leadplant -----
				Bundleflower -----
				Little bluestem -----
19: Konawa part -----	Eroded Sandy Savannah -----	Favorable Normal Unfavorable	2,500 1,600 1,250	Big bluestem -----
				Yellow Indiangrass -----
				Splitbeard bluestem -----
				Big bluestem -----
				Switchgrass -----
				Purpletop -----
				Other perennial forbs -----
				Tickclover -----
				Other perennial grasses -----
				Little bluestem -----
Stephenville part -----	Eroded Sandy Savannah -----	Favorable Normal Unfavorable	2,200 1,500 2,500	Big bluestem -----
				Yellow Indiangrass -----
				Switchgrass -----
				Tickclover -----
				Other perennial forbs -----
				Purpletop -----
				Splitbeard bluestem -----
				Other trees -----
				Other perennial grasses -----

Lela: 20	Heavy Bottomland	Favorable Normal Unfavorable	5,500 3,700 2,500	Big bluestem Switchgrass Yellow Indiangrass Prairie cordgrass Western wheatgrass Tall dropseed Perennial sunflower Goldenrod Sedges Other trees
Lucien: 21	Shallow Prairie	Favorable Normal Unfavorable	3,000 2,100 1,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Tall dropseed Scribner panicum Side-oats grama Prairie-clover Dotted gayfeather Other trees
Nash part	Loamy Prairie	Favorable Normal Unfavorable	5,200 3,600 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Side-oats grama Blue grama Tall dropseed Other perennial forbs Dotted gayfeather Other shrubs
McLain: 22	Heavy Bottomland	Favorable Normal Unfavorable	5,500 4,200 3,000	Big bluestem Switchgrass Yellow Indiangrass Prairie cordgrass Western wheatgrass Canada wildrye Perennial sunflower Goldenrod Sedges Other trees
Minco: 23, 24, 25, 26, 27	Loamy Prairie	Favorable Normal Unfavorable	5,500 3,700 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Side-oats grama Blue grama Tall dropseed Other perennial forbs Dotted gayfeather Other trees

TABLE 3.—*Composition of the potential native plant community on rangeland—Continued*

Soil name and map symbol	Range site name	Potential production		Common plant
		Kind of year	Dry Weight	
Nash: 28, 29	Loamy Prairie	Favorable Normal Unfavorable	Lbs/ac 5,200 3,600 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Side-oats grama Blue grama Tall dropseed Other perennial forbs Dotted gayfeather Other shrubs
¹ 30: Nash part	Loamy Prairie	Favorable Normal Unfavorable	5,200 3,600 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Side-oats grama Blue grama Tall dropseed Other perennial forbs Dotted gayfeather Other shrubs
Lucien part	Shallow Prairie	Favorable Normal Unfavorable	3,000 2,100 1,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Tall dropseed Scribner panicum Side-oats grama Prairie-clover Dotted gayfeather Other trees
Noble: 31	Sandy Savannah	Favorable Normal Unfavorable	4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial grasses Other trees Other shrubs Other perennial forbs

132: Noble part	Sandy Savannah	Favorable Normal Unfavorable		4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial grasses Other trees Other shrubs Other perennial forbs
Darnell part	Shallow Savannah	Favorable Normal Unfavorable		3,000 2,100 1,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Side-oats grama Purpletop Scribner panicum Tall dropseed Hairy sunflower Other trees Other shrubs
Norge: 33, 34, 35	Loamy Prairie	Favorable Normal Unfavorable		5,500 3,700 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Side-oats grama Blue grama Tall dropseed Other perennial forbs Dotted gayfeather Other trees
Pocasset: 36	Loamy Bottomland	Favorable Normal Unfavorable		8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Sedges Heath aster Compassplant Other trees
Pond Creek: 37, 38	Loamy Prairie	Favorable Normal Unfavorable		5,500 3,700 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Canada wildrye Sideoats grama Blue grama Tall dropseed Other perennial forbs Dotted gayfeather Other trees

TABLE 3.—Composition of the potential native plant community on rangeland—Continued

Soil name and map symbol	Range site name	Potential production		Common plant name
		Kind of year	Dry Weight	
Port: 39, 40	Loamy Bottomland	Favorable Normal Unfavorable	Lbs/ac 8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Compassplant Heath aster Sedges Other trees
Pulaski: 41	Loamy Bottomland	Favorable Normal Unfavorable	8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Compassplant Sedges Heath aster Other trees
Quinlan: 142: Quinlan part	Shallow Prairie	Favorable Normal Unfavorable	2,500 1,800 1,300	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Tall dropseed Scribner panicum Side-oats grama Prairie-clover Dotted gayfeather Other trees
Rock outcrop part. Reinach: 43	Loamy Bottomland	Favorable Normal Unfavorable	8,500 6,100 4,500	Big bluestem Yellow Indiangrass Switchgrass Little bluestem Eastern gamagrass Tall dropseed Beaked panicum Compassplant Heath aster Sedges Other trees

Renfrow: 44, 45	Claypan Prairie	Favorable Normal Unfavorable	4,000 2,800 2,000	Little bluestem Big bluestem Switchgrass Yellow Indiangrass Side-oats grama Blue grama Buffalograss Leadplant Goldenrod Coralberry
			2,000 1,400 1,000	Side-oats grama Blue grama Buffalograss Little bluestem Prairie-clover Dalea species Maximilian sunflower Other perennial grasses Other perennial forbs
46	Eroded Clay	Favorable Normal Unfavorable	4,000 2,800 2,000	Little bluestem Big bluestem Switchgrass Yellow Indiangrass Side-oats grama Blue grama Buffalograss Leadplant Goldenrod Coralberry
			1,800 1,250 800	Blue grama Little bluestem Western wheatgrass Tall dropseed White tridens Silver bluestem Side-oats grama Fall witchgrass Buffalograss Dotted gayfeather
Hinkle part	Slickspot	Favorable Normal Unfavorable	4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial forbs Other shrubs Other trees Other perennial grasses
			2,200 1,500 1,100	Little bluestem Yellow Indiangrass Big bluestem Switchgrass Purpletop Tickclover Other perennial grasses Other trees Other perennial forbs Splitbeard bluestem
Stephenville: 48, 49, 50	Sandy Savannah	Favorable Normal Unfavorable	4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial forbs Other shrubs Other trees Other perennial grasses
			2,200 1,500 1,100	Little bluestem Yellow Indiangrass Big bluestem Switchgrass Purpletop Tickclover Other perennial grasses Other trees Other perennial forbs Splitbeard bluestem
51	Eroded Sandy Savannah	Favorable Normal Unfavorable	4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial forbs Other shrubs Other trees Other perennial grasses
			2,200 1,500 1,100	Little bluestem Yellow Indiangrass Big bluestem Switchgrass Purpletop Tickclover Other perennial grasses Other trees Other perennial forbs Splitbeard bluestem

TABLE 3.—Composition of the potential native plant community on rangeland—Continue

Soil name and map symbol	Range site name	Potential production		Common plant
		Kind of year	Dry Weight	
Stephenville: ¹⁵² Stephenville part	Sandy Savannah	Favorable Normal Unfavorable	4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial forbs Other shrubs Other trees Other perennial grasses
Darnell part	Shallow Savannah	Favorable Normal Unfavorable	3,200 2,100 1,400	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Side-oats grama Purpletop Scribner panicum Tall dropseed Hairy sunflower Other trees Other shrubs
¹⁵³ Stephenville part	Deep Sand Savannah	Favorable Normal Unfavorable	4,000 2,800 2,000	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Scribner panicum Purpletop Side-oats grama Perennial lespedeza Other trees Arrowfeather three-awn
Eufaula part	Deep Sand Savannah	Favorable Normal Unfavorable	4,000 2,800 2,000	Little bluestem Big bluestem Sand bluestem Yellow Indiangrass Switchgrass Purpletop Arrowfeather three-awn Scribner panicum Side-oats grama Perennial lespedeza Other trees
¹⁵⁴ Stephenville part	Sandy Savannah	Favorable Normal Unfavorable	4,500 3,300 2,500	Little bluestem Big bluestem Yellow Indiangrass Switchgrass Perennial sunflower Other perennial forbs Other shrubs Other trees Other perennial grasses

Stephenville: Pulaski part	Loamy Bottomland	Favorable Normal Unfavorable	8,500	Big bluestem
			6,100	Yellow Indiangrass
			4,500	Switchgrass
				Little bluestem
Teller: 55	Loamy Prairie	Favorable Normal Unfavorable		Eastern gamagrass
				Tall dropseed
				Beaked panicum
				Compassplant
56, 57, 58	Loamy Prairie	Favorable Normal Unfavorable		Sedges
				Heath aster
				Other trees
Tivoli: 59	Dune	Favorable Normal Unfavorable	5,500	Little bluestem
			3,700	Big bluestem
			2,500	Yellow Indiangrass
				Switchgrass
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable		Canada wildrye
				Side-oats grama
				Blue grama
				Tall dropseed
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable		Dotted gayfeather
				Other perennial forbs
				Other trees
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable	2,000	Little bluestem
			1,400	Sand bluestem
			1,000	Big sandreed
				Texas bluegrass
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable		Sand lovegrass
				Scribner panicum
				Sand dropseed
				Perennial lespedeza
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable		Other perennial forbs
				Other perennial grasses
				Other trees
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable	4,500	Little bluestem
			3,300	Big bluestem
			2,500	Yellow Indiangrass
				Switchgrass
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable		Perennial sunflower
				Other shrubs
				Other perennial forbs
				Other trees
Windthorst: 60, 61	Sandy Savannah	Favorable Normal Unfavorable		Other perennial grasses

TABLE 3.—*Composition of the potential native plant community on rangeland*—Continue

Soil name and map symbol	Range site name	Potential production		Common plant
		Kind of year	Dry Weight	
Yahola: 62 -----	Loamy Bottomland -----	Favorable Normal Unfavorable	Lbs/ac 8,500 6,100 4,500	Big bluestem -----
				Yellow Indiangrass -----
				Switchgrass -----
				Little bluestem -----
Zaneis: 63, 64, 65 -----	Loamy Prairie -----	Favorable Normal Unfavorable		Eastern gamagrass -----
				Tall dropseed -----
				Beaked panicum -----
				Compassplant -----
				Sedges -----
				Heath aster -----
				Other trees -----
				Little bluestem -----
				Big bluestem -----
				Yellow Indiangrass -----
66 -----	Eroded Prairie -----	Favorable Normal Unfavorable	2,500 1,700 1,100	Switchgrass -----
				Canada wildrye -----
				Side-oats grama -----
				Bluegrass -----
				Tall dropseed -----
				Other perennial forbs -----
				Dotted gayfeather -----
				Other trees -----
				Little bluestem -----
				Big bluestem -----
				Side-oats grama -----
				Tall dropseed -----
				Yellow Indiangrass -----
				Switchgrass -----
				Blue grama -----
				Prairie-clover -----
				Perennial sunflower -----
				Heath aster -----
				Other trees -----

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and mapping unit.

one in which growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry herbage produced per acre each year by the potential plant community. All herbage, both that which is highly palatable and that which is unpalatable to livestock, is included. Some of the herbage also is grazed extensively by wildlife. Plant species that have special value for livestock forage are mentioned in the description of each soil mapping unit.

Common names are listed for the grasses, forbs, and shrubs that make up most of the potential plant community on each soil. Under the heading Composition in table 3, the proportion of each species is presented as the percentage in dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the season when the forage is grazed. All of the herbage produced is normally not used.

Range management requires, in addition to knowledge of the kind of soil and the potential plant community, an evaluation of the present condition of the range vegetation in relation to its potential production. Range condition is an expression of how the present plant community compares with the potential

plant community on a particular kind of soil and range site. The more nearly alike the present kinds and amounts of plants and the potential plant community, the better the range condition. The usual objective in range management is to manage grazing so that the plants growing on a site are about the same in kind and amount as the potential native plant community for that site. Such management generally results in the maximum production of herbage, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, or provides other benefits, as well as protecting soil and water resources.

The major management concern on most of the rangeland is control of grazing so that the kinds and amounts of plants that make up the potential plant community are reestablished. Controlling brush and minimizing soil blowing are also important management concerns. If sound range management based on the soil survey information and rangeland inventories is applied, the potential is good for increasing the productivity of range in the area.

About 35 percent of the rangeland in the survey area is in the Loamy Prairie range site (fig. 4), which is intermediate in productivity. On this site the aver-



Figure 4.—Loamy Prairie range site. The soil is Grant silt loam, 2 to 5 percent slopes, eroded.

age production is about 3,700 pounds of herbage annually. The Shallow Savannah and Shallow Prairie range sites, which make up about 7 percent of the rangeland, are low in productivity. On these sites the average production is about 2,100 pounds of herbage annually. The rest of the rangeland is made up of the other sites listed in table 3. On these sites the average production ranges from 1,250 to 7,100 pounds of herbage annually.

The potential is good for increasing the productivity of range if sound management based on rangeland inventories and soil survey information is applied.

Windbreaks and Environmental Plantings

This section describes the suitability of the soils in Grady County for trees. Post oak, blackjack oak, and winged elm grow on Darnell, Stephenville, Windthorst, and Noble soils. Predominant species on Eufaula, Dougherty, and Konawa soils are post oak, blackjack oak, and chinquapin oak. Eastern cottonwood is the major species along the flood plains of the Canadian and Washita Rivers. American elm is the major species along the creeks and smaller drainageways. Pecan is an important species along the flood plains of the creeks. Black willow is the dominant species on Gracemont and Gracemore soils. Among other native species are American sycamore, black walnut, bur oak, osage-orange, black locust, white mulberry, buttonbush, American plum, blackhaw, chittamwood, roughleaf dogwood, hawthorn, eastern redbud, western soapberry, saltcedar, and eastern redcedar.

Woodland in Grady County has limited economic value, but is of value for watershed and wildlife and for esthetic purposes.

Windbreaks are established to protect livestock, buildings, and yards from winds and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of both broadleaf and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind and hold snow on the fields, and they also provide food and cover for wildlife.

Environmental plantings help to beautify and screen homes and other buildings and to abate noise around them. The plants, mostly evergreen shrubs and trees, are closely spaced. Healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 4 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 4, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from the local office of the Soil Conservation Service, Extension Service, or Oklahoma Forestry Division, or from local nurserymen.

Engineering³

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community decision makers and planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the tables in this section are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for erodibility, permeability, risk of corrosion, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values may be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to—(1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil

³ JESSE L. MCMASTERS, engineer, Soil Conservation Service, helped prepare this section.

TABLE 4.—*Windbreaks and environmental plantings*

[Absence of an entry means height data are not available. Dashes mean the species does not grow well on the soil]

Soil name and map symbol	Expected height in feet of specified trees at 20 years of age					
	Austrian pine	Eastern redcedar	Eastern cottonwood	Green ash	Loblolly pine	Osage orange
Amber: 1	35	35	75	55	45	
Bethany: 2	30	25	55		40	20
Cyril: 3	35	35	75	55	45	
Dale: 4	35	35	75	55	45	
Darnell: 5:						
Darnell part		18				
Noble part	30	30	65		40	
Dougherty: 6:		22				
7:						
Dougherty part		22				
Eufaula part		22				
Eufaula: 8		22				
9:						
Eufaula part		22				
Stephenville part	30	30	65		40	
Gracemont: 10			85	65		
Gracemore: 11			85	65		
Grant: 12, 13, 14	30	30	65		40	
15:						
Grant part	30	30	65		40	
Port part	35	35	75	55	45	
Keokuk: 16	35	35	75	55	45	
Kirkland: 17		25				20
Konawa: 18	30	30	65		40	
19:						
Konawa part		20				
Stephenville part		20				
Lela: 20		25	60	40		20
Lucien: 21:						
Lucien part		18				
Nash part	30	30	65		40	
McLain: 22	35	35	75	55	45	

TABLE 4.—*Windbreaks and environmental plantings—Continued*

Soil name and map symbol	Expected height in feet of specified trees at 20 years of age					
	Austrian pine	Eastern redcedar	Eastern cottonwood	Green ash	Loblolly pine	Osage orange
Minco: 23, 24, 25, 26, 27 -----	30	30	65		40	
Nash: 28, 29 -----	30	30	65		40	
¹ 30: Nash part -----	30	30	65		40	
Lucien part -----		18				
Noble: 31 -----	30	30	65		40	
¹ 32: Noble part -----	30	30	65		40	
Darnell part -----		18				
Norge: 33, 34, 35 -----	30	30	65		40	
Pocasset: 36 -----	35	35	75	55	45	
Pond Creek: 37, 38 -----	30	30	65		40	
Port: 39, 40 -----	35	35	75	55	45	
Pulaski: 41 -----	35	35	75	55	45	
Quinlan: ¹ 42: Quinlan part -----		18				
Rock outcrop part -----						
Reinach: 43 -----	35	35	75	45		
Renfrow: 44, 45 -----		25				
46 -----						
¹ 47: Renfrow part -----						
Hinkle part -----						
Stephenville: 48, 49, 50 -----	30	30	65		40	
51 -----		20				
¹ 52: Stephenville part -----	30	30	65		40	
Darnell part -----		20				
¹ 53: Stephenville part -----	30	30	65		40	
Eufaula part -----		22				
¹ 54: Stephenville part -----	30	30	65		40	
Pulaski part -----	35	35	75	55	45	
Teller: 55, 56, 57, 58 -----	30	30	65		40	
Tivoli: 59 -----		22				

TABLE 4.—Windbreaks and environmental plantings—Continued

Soil name and map symbol	Expected height in feet of specified trees at 20 years of age					
	Austrian pine	Eastern redcedar	Eastern cottonwood	Green ash	Loblolly pine	Osage orange
Windthorst: 60, 61		25				20
Yahola: 62	35	35	75	55	45	
Zaneis: 63, 64, 65 66	30	30 20	65		40	

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 5 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 6, for sanitary facilities; and table 8, for water management. Table 7 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have different meanings in soil science and in engineering; the Glossary defines many of these terms.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 5. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by the soil wetness of a seasonal high water table, the texture and consistence of soils, the tendency

of soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 5 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 5 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel; crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil and the soil texture,

TABLE 5.—*Ratings of soils as construction sites*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings
Amber: 1	Moderate: floods	Severe: floods	Severe: floods	Severe: floods
Bethany: 2	Severe: too clayey	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Cyril: 3	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Date: 4	Moderate: floods	Severe: floods	Severe: floods	Severe: floods
Darnell: 15	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope
Noble part	Moderate: slope	Moderate: slope	Moderate: slope	Severe: slope
Dougherty: 6	Moderate: cutbanks cave.	Slight	Slight	Slight
17: Dougherty part	Moderate: cutbanks cave.	Slight	Slight	Moderate: slope
Eufaula part	Severe: cutbanks cave	Slight	Slight	Moderate: slope
Eufaula: 8	Severe: cutbanks cave	Moderate: slope	Moderate: slope	Severe: slope
19: Eufaula part	Severe: cutbanks cave	Moderate: slope	Moderate: slope	Severe: slope
Stephenville part	Moderate: depth to rock, slope.	Moderate: slope	Moderate: depth to rock, slope.	Severe: slope
Gracemont: 10	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Gracemore: 11	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Grant: 12, 13, 14	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.

¹ ₁₅ : Grant part	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.
Port part	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Keokuk: 16	Moderate: floods	Severe: floods	Severe: floods	Severe: floods
Kirkland: 17	Severe: too clayey	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Konawa: 18	Slight	Slight	Slight	Slight
¹ ₁₉ : Konawa part	Slight	Slight	Slight	Moderate: slope
Stephenville part	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope
Lela: 20	Severe: floods, wetness, too clayey.	Severe: low strength, floods, shrink-swell.	Severe: low strength, floods, shrink-swell.	Severe: low strength, floods, shrink-swell.
Lucien: ¹ ₂₁ : Lucien part	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Severe: slope
Nash part	Moderate: depth to rock, slope.	Moderate: slope, low strength.	Moderate: depth to rock, slope.	Severe: slope
McLain: 22	Severe: too clayey	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.
Minco: 23, 27	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength, slope.
24	Severe: slope	Severe: slope	Severe: slope	Severe: slope
25, 26	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
Nash: 28, 29	Moderate: depth to rock.	Moderate: low strength.	Moderate: depth to rock.	Moderate: slope, low strength.
¹ ₃₀ : Nash part	Moderate: depth to rock.	Moderate: low strength.	Moderate: depth to rock.	Moderate: low strength.
Lucien part	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
Noble: 31	Slight	Slight	Slight	Slight
¹ ₃₂ : Noble part	Slight	Slight	Slight	Moderate: slope

TABLE 5.—*Ratings of soils as construction sites—Continued*

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings
Darnell part -----	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock, slope.
Norge: 33, 34, 35 -----	Moderate: too clayey	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.
Pocasset: 36 -----	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Pond Creek: 37, 38 -----	Moderate: too clayey	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell.
Port: 39, 40 -----	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Pulaski: 41 -----	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Quinlan: ¹ 42: Quinlan part -----	Severe: slope, depth to rock.	Severe: slope	Severe: slope	Severe: slope
Rock outcrop part.				
Reinach: 43 -----	Moderate: floods	Severe: floods	Severe: floods	Severe: floods
Renfrow: 44, 45, 46 -----	Severe: too clayey	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
¹ 47: Renfrow part -----	Severe: too clayey	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Hinkle part -----	Severe: too clayey	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Stephenville: 48, 50 -----	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight
49, 51 -----	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope
¹ 52: Stephenville part -----	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope
Darnell part -----	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock, slope.

¹ 53:	Stephenville part	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope
	Eufaula part	Severe: cutbanks cave	Slight	Slight	Moderate: slope
¹ 54:	Stephenville part	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope
	Pulaski part	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Teller: 55, 57		Slight	Slight	Slight	Slight
56, 58		Slight	Slight	Slight	Moderate: slope
Tivoli: 59		Severe: cutbanks cave, too sandy.	Moderate: slope	Moderate: slope	Severe: slope
Windthorst: 60, 61		Moderate: too clayey	Moderate: shrink- swell.	Moderate: shrink- swell.	Moderate: shrink- swell.
Yahola: 62		Severe: floods	Severe: floods	Severe: floods	Severe: floods
Zaneis: 63, 65		Slight	Moderate: shrink- swell, low strength.	Moderate: shrink-swelling, low strength.	Moderate: shrink-swelling, low strength.
64, 66		Slight	Moderate: shrink- swell, low strength.	Moderate: shrink-swelling, low strength.	Moderate: shrink-swelling, low strength, slope.

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and ping unit.

TABLE 6.—*Soil ratings for sanitary facilities*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill
Amber: 1	Moderate: floods	Moderate: seepage	Moderate: floods	Moderate: floods
Bethany: 2	Severe: percs slowly	Slight	Severe: too clayey	Slight
Cyril: 3	Severe: floods	Severe: floods	Severe: floods	Severe: floods
Dale: 4	Moderate: floods	Moderate: seepage	Moderate: floods	Moderate: floods
Darnell: 15: Darnell part	Severe: depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: seepage	Severe: seepage, slope.
Noble part	Moderate: slope	Severe: seepage, slope.	Severe: seepage	Severe: seepage, slope.
Dougherty: 6	Slight	Severe: seepage	Severe: seepage	Slight
17: Dougherty part	Slight	Severe: seepage	Severe: seepage	Slight
Eufaula part	Slight	Severe: seepage	Severe: seepage	Severe: seepage
Eufaula: 8	Moderate: slope	Severe: seepage	Severe: seepage	Severe: seepage
19: Eufaula part	Moderate: slope	Severe: seepage	Severe: seepage	Severe: seepage
Stephenville part	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Moderate: depth to rock.	Moderate: slope
Gracemont: 10	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: floods, seepage.	Severe: wetness, floods, seepage.
Gracemore: 11	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: floods, seepage, wetness.	Severe: wetness, floods, seepage.
Grant: 12, 13, 14	Moderate: depth to rock.	Moderate: seepage, depth to rock.	Moderate: depth to rock, too clayey.	Slight
15: Grant part	Moderate: depth to rock.	Moderate: seepage, depth to rock.	Moderate: depth to rock, too clayey.	Slight
Port part	Severe: floods	Severe: floods	Severe: floods	Severe: floods

Keokuk: 16	Moderate: floods	Moderate: seepage	Moderate: floods, seepage.	Moderate: floods
Kirkland: 17	Severe: percs slowly	Slight	Severe: too clayey	Slight
Konawa: 18	Slight	Severe: seepage	Severe: seepage	Slight
^{1 19:} Konawa part	Slight	Severe: seepage	Severe: seepage	Slight
Stephenville part	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
Lela: 20	Severe: percs slowly, floods.	Slight	Severe: floods, too clayey.	Severe: floods
Lucien: ^{1 21:} Lucien part	Severe: depth to rock	Severe: seepage, depth to rock.	Severe: seepage, depth to rock.	Severe: seepage
Nash part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Moderate: depth to rock.	Moderate: slope
McLain: 22	Severe: percs slowly	Slight	Severe: too clayey	Moderate: floods
Minco: 23, 26, 27	Slight	Moderate: seepage, slope.	Slight	Slight
24	Severe: slope	Severe: slope	Moderate: slope	Severe: slope
25	Slight	Moderate: seepage	Slight	Slight
Nash: 28, 29	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
^{1 30:} Nash part	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
Lucien part	Severe: depth to rock	Severe: seepage, depth to rock.	Severe: seepage	Severe: seepage
Noble: 31	Slight	Severe: seepage, slope.	Severe: seepage	Severe: seepage
^{1 32:} Noble part	Slight	Severe: seepage, slope.	Severe: seepage	Severe: seepage
Darnell part	Severe: depth to rock	Severe: depth to rock, seepage, slope.	Severe: seepage	Severe: seepage

TABLE 6.—*Soil ratings for sanitary facilities—Continued*

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill
Norge: 33	Severe: percs slowly	Slight	Moderate: too clayey	Slight
34, 35	Severe: percs slowly	Moderate: slope	Moderate: too clayey	Slight
Pocasset: 36	Severe: floods	Severe: floods, seepage.	Severe: floods, seepage.	Severe: floods
Pond Creek: 37	Severe: percs slowly	Slight	Moderate: too clayey	Slight
38	Severe: percs slowly	Moderate: slope	Moderate: too clayey	Slight
Port: 39, 40	Severe: floods	Moderate: seepage	Severe: floods	Severe: floods
Pulaski: 41	Severe: floods	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.
Quinlan: 142: Quinlan part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Moderate: depth to rock.	Severe: slope
Rock outcrop part.				
Reinach: 43	Moderate: floods	Moderate: seepage	Moderate: floods	Moderate: floods
Renfrow: 44, 45, 46	Severe: percs slowly	Moderate: slope	Severe: too clayey	Slight
147: Renfrow part	Severe: percs slowly	Moderate: slope	Severe: too clayey	Slight
Hinkle part	Severe: percs slowly	Moderate: slope	Severe: too clayey	Slight
Stephenville: 48, 49, 50, 51	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
152: Stephenville part	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
Darnell part	Severe: depth to rock	Severe: depth to rock, seepage, slope.	Severe: seepage	Severe: seepage
153: Stephenville part	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
Eufaula part	Slight	Severe: seepage	Severe: seepage	Severe: seepage

¹ 54:	Severe: depth to rock	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight
Stephenville part	Severe: floods	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.
Pulaski part	Slight	Severe: seepage	Severe: seepage	Slight
Teller: 55, 56, 57, 58	Moderate: slope	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage
Tivoli: 59	Severe: percs slowly	Moderate: slope	Moderate: too clayey	Slight
Windthorst: 60, 61	Severe: floods	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.
Yahola: 62	Severe: percs slowly	Moderate: depth to rock, slope.	Moderate: too clayey, depth to rock.	Slight
Zaneis: 63, 64, 65, 66				

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and ping unit.

TABLE 7.—*Ratings of soils as sources of construction material*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." "F" means soil was not rated.]

Soil name and map symbol	Road fill	Sand	Gravel
Amber: 1	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines
Bethany: 2	Poor: low strength, shrink-swell.	Unsuited	Unsuited
Cyril: 3	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines
Dale: 4	Fair: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines
Darnell: 15:			
Darnell part	Fair: low strength, thin layer.	Unsuited	Unsuited
Noble part	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines
Dougherty: 6	Fair: low strength	Poor	Unsuited
17:			
Dougherty part	Fair: low strength	Poor	Unsuited
Eufaula part	Good	Poor	Unsuited
Eufaula: 8	Good	Poor	Unsuited
19:			
Eufaula part	Good	Poor	Unsuited
Stephenville part	Fair: thin layer, low strength.	Unsuited	Unsuited
Gracemont: 10	Fair: wetness, low strength.	Unsuited: excess fines	Unsuited: excess fines
Gracemore: 11	Fair: low strength, wet- ness.	Poor	Unsuited
Grant: 12, 13, 14	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines
15:			
Grant part	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines
Port part	Fair: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines

Keokuk: 16	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
Kirkland: 17	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Unsuited
Konawa: 18	Fair: low strength	Poor: excess fines	Poor: excess fines	Unsuited: excess fines
¹ 19: Konawa part	Fair: low strength	Poor: excess fines	Poor: excess fines	Unsuited: excess fines
Stephenville part	Fair: thin layer, low strength.	Unsuited	Unsuited	Unsuited
Lela: 20	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Unsuited
Lucien: ¹ 21: Lucien part	Fair: low strength, thin layer.	Unsuited	Unsuited	Unsuited
Nash part	Fair: thin layer	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
McLain: 22	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Unsuited
Minco: 23, 25, 26, 27	Fair: low strength	Unsuited	Unsuited	Unsuited
24	Fair: low strength, slope.	Unsuited	Unsuited	Unsuited
Nash: 28, 29	Fair: thin layer	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
¹ 30: Nash part	Fair: thin layer	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
Lucien part	Fair: low strength	Unsuited	Unsuited	Unsuited
Noble: 31	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
¹ 32: Noble part	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
Darnell part	Fair: low strength, thin layer.	Unsuited	Unsuited	Unsuited
Norge: 33, 34, 35	Poor: low strength	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
Pocasset: 36	Poor: low strength	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines
Pond Creek: 37, 38	Poor: low strength	Unsuited: excess fines	Unsuited: excess fines	Unsuited: excess fines

TABLE 7.—*Ratings of soils as sources of construction material*—Continued

Soil name and map symbol	Road fill	Sand	Gravel
Port: 39, 40	Fair: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines
Pulaski: 41	Fair: low strength	Poor	Unsuited
Quinlan: ¹ 42: Quinlan part	Fair: low strength, thin layer.	Unsuited	Unsuited
Rock outcrop part.			
Reinach: 43	Fair: low strength	Unsuited: excess fines	Unsuited: excess fines
Renfrow: 44, 45, 46	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines
¹ 47: Renfrow part	Poor: low strength, shrink-swell.	Unsuited: excess fines	Unsuited: excess fines
Hinkle part	Poor: low strength, shrink-swell.	Unsuited	Unsuited
Stephenville: 48, 49, 50, 51	Fair: thin layer, low strength.	Unsuited	Unsuited
¹ 52: Stephenville part	Fair: thin layer, low strength.	Unsuited	Unsuited
Darnell part	Fair: low strength, thin layer.	Unsuited	Unsuited
¹ 53: Stephenville part	Fair: thin layer, low strength.	Unsuited	Unsuited
Eufaula part	Fair: low strength	Poor	Unsuited
¹ 54: Stephenville part	Fair: thin layer, low strength.	Unsuited	Unsuited
Pulaski part	Fair: low strength	Poor	Unsuited
Teller: 55, 56, 57, 58	Good	Unsuited: excess fines	Unsuited: excess fines
Tivoli: 59	Good	Fair	Unsuited: excess fines
Windthorst: 60, 61	Poor: low strength	Unsuited: excess fines	Unsuited: excess fines

Yahola: 62		Fair: low strength	Poor		Unsuited: excess fines	Unsuited: excess fines
Zaneis: 63, 64, 65, 66		Poor: low strength		Unsuited: excess fines		Unsuited: excess fines

¹This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and ping unit.

TABLE 8.—*Water management*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Entry means soil was not evaluated.]

Soil name and map symbol	Limitations for—		Features affecting—		
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Amber: 1	Moderate: seepage.	Moderate: unstable fill, piping, compressible.	Not needed	Erodes easily, floods.	Erodes easily, floods.
Bethany: 2	Slight	Moderate: unstable fill, compressible.	Not needed	Slow intake	Percolates slowly
Cyril: 3	Moderate: seepage.	Moderate: unstable fill, compressible.	Not needed	Floods	Not needed
Dale: 4	Moderate: seepage.	Moderate: unstable fill, piping, compressible.	Not needed	Favorable	Favorable
Darnell: 5	Severe: depth to rock, seepage.	Severe: thin layer.	Not needed	Slope, rooting depth.	Slope
Noble part	Severe: seepage.	Moderate: unstable fill, low strength.	Not needed	Slope	Slope
Dougherty: 6	Severe: seepage.	Moderate: unstable fill, compressible.	Not needed	Fast intake, seepage.	Erodes easily, too sandy.
17: Dougherty part	Severe: seepage.	Moderate: unstable fill, compressible.	Not needed	Fast intake, seepage.	Erodes easily, too sandy.
Eufaula part	Severe: seepage.	Moderate: unstable fill, seepage.	Not needed	Seepage, fast intake, droughty.	Seepage, fast intake, droughty.
Eufaula: 8	Severe: seepage.	Moderate: unstable fill, seepage.	Not needed	Seepage, fast intake, droughty.	Seepage, fast intake, droughty.
19: Eufaula part	Severe: seepage.	Moderate: unstable fill, piping.	Not needed	Seepage, fast intake, droughty.	Seepage, fast intake, droughty.

Stephenville part -----	Severe: depth to rock.	Moderate: thin layer.	Not needed -----	Slope -----	Too sandy, sh
Gracemont: 10 -----	Severe: seepage.	Moderate: unstable fill, seepage.	Floods -----	Wetness, seepage, floods.	Not needed
Gracemore: 11 -----	Severe: seepage.	Moderate: unstable fill, low strength.	Wetness, floods, cutbanks cave.	Wetness, seepage, floods.	Not needed
Grant: 12, 13, 14 -----	Moderate: seepage.	Moderate: unstable fill, compressible.	Not needed -----	Erodes easily -----	Erodes easily
15: Grant part -----	Moderate: seepage.	Moderate: unstable fill, compressible.	Not needed -----	Erodes easily -----	Erodes easily
Port part -----	Moderate: seepage.	Moderate: unstable fill, compressible, piping.	Not needed -----	Floods -----	Not needed
Keokuk: 16 -----	Moderate: seepage.	Moderate: piping, compressible, low strength.	Not needed -----	Favorable -----	Favorable
Kirkland: 17 -----	Slight -----	Severe: com- pressible, piping.	Not needed -----	Slow intake -----	Peres slowly
Konawa: 18 -----	Severe: seepage.	Moderate: low strength, unstable fill.	Not needed -----	Erodes easily -----	Erodes easily
19: Konawa part -----	Severe: seepage.	Moderate: low strength, unstable fill.	Not needed -----	Erodes easily -----	Erodes easily
Stephenville part -----	Severe: depth to rock.	Moderate: thin layer.	Not needed -----	Erodes easily -----	Erodes easily
Lela: 20 -----	Slight -----	Moderate: unstable fill, compressible.	Peres slowly, wetness, floods.	Slow intake, wetness.	Not needed
Lucien: 21: -----	Severe: depth to rock, seepage.	Severe: thin layer.	Not needed -----	Slope, rooting depth.	Not needed
Nash part -----	Severe: depth to rock.	Moderate: unstable fill, piping, thin layer.	Not needed -----	Slope -----	Slope -----

TABLE 8.—*Water management—Continued*

Soil name and map symbol	Limitations for—		Features affecting—		
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces : diversion
McLain: 22 -----	Slight -----	Severe: compressible.	Not needed -----	Slow intake -----	Not needed
Minco: 23, 26, 27 -----	Moderate: seepage.	Moderate: unstable fill, compressible, piping.	Not needed -----	Erodes easily -----	Erodes easily
24 -----	Moderate: seepage.	Moderate: unstable fill, compressible, piping.	Not needed -----	Slope, erodes easily.	Slope, erodes easily.
25 -----	Moderate: seepage.	Moderate: unstable fill, compressible, piping.	Not needed -----	Favorable -----	Favorable
Nash: 28, 29 -----	Severe: depth to rock.	Moderate: unstable fill, piping, thin layer.	Not needed -----	Erodes easily -----	Erodes easily
¹ 30: Nash part -----	Severe: depth to rock.	Moderate: unstable fill, piping, thin layer.	Not needed -----	Erodes easily -----	Erodes easily
Lucien part -----	Severe: depth to rock, seepage.	Severe: thin layer.	Not needed -----	Rooting depth, seepage.	Depth to root
Noble: 31 -----	Severe: seepage.	Moderate: unstable fill, low strength.	Not needed -----	Seepage -----	Seepage -----
¹ 32: Noble part -----	Severe: seepage.	Moderate: unstable fill, low strength.	Not needed -----	Seepage -----	Seepage -----
Darnell part -----	Severe: depth to rock, seepage.	Severe: thin layer.	Not needed -----	Rooting depth, erodes easily.	Depth to root, erodes easily
Norge: 33 -----	Moderate: seepage.	Moderate: unstable fill.	Not needed -----	Favorable -----	Favorable
34, 35 -----	Moderate: seepage.	Moderate: unstable fill.	Not needed -----	Erodes easily -----	Erodes easily

Pocasset: 36	Severe: seepage.	Moderate: unstable fill, compressible.	Not needed	Favorable	Not needed
Pond Creek: 37	Moderate: seepage.	Moderate: unstable fill.	Not needed	Favorable	Favorable
38	Moderate: seepage.	Moderate: unstable fill.	Not needed	Slope	Favorable
Port: 39, 40	Moderate: seepage.	Moderate: unstable fill, compressible, piping.	Not needed	Floods	Not needed
Pulaski: 41	Severe: seepage.	Moderate: unstable fill, seepage.	Not needed	Floods	Not needed
Quinlan: 42:	Severe: depth to rock.	Severe: thin layer.	Not needed	Droughty, slope, rooting depth.	Depth to rock slope.
Rock outcrop part.					
Reinach: 43	Moderate: seepage.	Moderate: unstable fill, compressible, piping.	Not needed	Favorable	Not needed
Renfrow: 44, 45, 46	Slight	Moderate: unstable fill, compressible.	Not needed	Erodes easily, percs slowly.	Erodes easily percs slow
¹ 47: Renfrow part	Slight	Moderate: unstable fill, compressible.	Not needed	Erodes easily, percs slowly.	Erodes easily percs slow
Hinkle part	Slight	Severe: unstable fill, low strength.	Percs slowly, excess salt.	Percs slowly, excess salt.	Percs slowly, erodes easi
Stephenville: 48, 49, 50, 51	Severe: depth to rock.	Moderate: thin layer.	Not needed	Erodes easily	Erodes easil
¹ 52: Stephenville part	Severe: depth to rock.	Moderate: thin layer.	Not needed	Erodes easily	Erodes easil
Darnell part	Severe: depth to rock, seepage.	Severe: thin layer.	Not needed	Rooting depth, erodes easily.	Depth to rock erodes easi
¹ 53: Stephenville part	Severe: depth to rock.	Moderate: thin layer.	Not needed	Erodes easily, fast intake.	Too sandy
Eufaula part	Severe: seepage.	Moderate: unstable fill, seepage.	Not needed	Seepage, fast in- take, droughty.	Seepage, fast intake, droughty.

TABLE 8.—*Water management*—Continued

Soil name and map symbol	Limitations for—		Features affecting—			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	
¹ 54: Stephenville part -----	Severe: depth to rock.	Moderate: thin layer.	Not needed -----	Erodes easily -----	Erodes easily -----	
Pulaski part -----	Severe: seepage.	Moderate: unstable fill, piping.	Not needed -----	Floods -----	Not needed -----	
Teller: 55, 56, 57, 58 -----	Severe: seepage.	Moderate: unstable fill.	Not needed -----	Erodes easily -----	Erodes easily piping.	
Tivoli: 59 -----	Severe: seepage.	Severe: unstable fill, seepage.	Not needed -----	Complex slope, erodes easily, droughty.	Complex slope, erodes easily, fast intake	
Windthorst: 60, 61 -----	Moderate: seepage.	Moderate: compressible.	Percs slowly -----	Percs slowly, erodes easily.	Percs slowly, erodes easily.	
Yahola: 62 -----	Severe: seepage.	Moderate: unstable fill, seepage.	Not needed -----	Floods -----	Not needed -----	
Zaneis: 63, 64, 65, 66 -----	Moderate: seepage, depth to rock.	Moderate: thin layer, unstable fill.	Not needed -----	Erodes easily -----	Erodes easily percs slowly	

This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and piping unit.

density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 6 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is indicated by the rating *slight*, soils are favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and as a result ground water supplies in the area may be contaminated.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level flow area

surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil at least 4 feet thick for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill refers to a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread, compacted in layers, and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 6 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for sanitary landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfills should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in

soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 7 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet, and described as the survey is made.

Road fill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about soil properties that determine such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 11 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

According to the Unified soil classification system, soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, high potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*, regardless of the quality of the suitable material.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 11.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, soils having large amounts of gravel, stones or soluble salt, steep soils, and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 8 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the rated use but can be overcome or modified by special planning and design. *Severe* means that the soil properties and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and is of favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth

to root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for waterways are slope, permeability, erodibility, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 9 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 6, and interpretations for dwellings without basements and for local roads and streets, given in table 5.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of paths and trails for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife Habitat⁴

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife will either be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 10 the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in—

1. Planning the use of parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.
4. Determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or main-

⁴JEROME F. SYKORA, biologist, Soil Conservation Service, helped prepare this section.

TABLE 9.—*Soil ratings for recreational development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe."]

Soil name and map symbols	Camp areas	Picnic areas	Playgrounds
Amber: 1	Severe: floods	Moderate: floods	Moderate: floods
Bethany: 2	Moderate: percs slowly	Slight	Moderate: percs slowly
Cyril: 3	Severe: floods	Moderate: floods	Moderate: floods
Dale: 4	Severe: floods	Slight	Slight
Darnell: 1 5: Darnell part	Moderate: slope	Moderate: slope	Severe: depth to rock, slope.
Noble part	Moderate: slope	Moderate: slope	Severe: slope
Dougherty: 6	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy
1 7: Dougherty part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy
Eufaula part	Moderate: too sandy	Moderate: too sandy	Severe: too sandy
Eufaula: 8	Moderate: too sandy	Moderate: too sandy	Severe: too sandy
1 9: Eufaula part	Moderate: too sandy	Moderate: too sandy	Severe: too sandy
Stephenville part	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope
Gracemont: 10	Severe: floods, wetness	Moderate: wetness, floods.	Moderate: wetness, floods.
Gracemore: 1 11	Severe: floods	Severe: floods	Severe: floods
Grant: 12, 13, 14	Slight	Slight	Moderate: slope
1 15: Grant part	Slight	Slight	Moderate: slope
Port part	Severe: floods	Severe: floods	Severe: floods
Keokuk: 16	Severe: floods	Moderate: floods	Moderate: floods
Kirkland: 17	Severe: percs slowly	Slight	Severe: percs slowly

Konawa: 18	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy
¹ 19: Konawa part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy
Stephenville part	Slight	Slight	Moderate: slope
Lela: 20	Severe: floods, percs slowly, too clayey.	Severe: too clayey	Severe: percs slowly, too clayey.
Lucien: ¹ 21:	Moderate: slope	Moderate: slope	Severe: depth to rock
Lucien part	Moderate: slope	Moderate: slope	Severe: slope
Nash part	Severe: floods	Moderate: floods	Moderate: floods, percs slowly.
McLain: 22			
Minco: 23	Slight	Slight	Severe: slope
24	Severe: slope	Severe: slope	Severe: slope
25	Slight	Slight	Slight
26, 27	Slight	Slight	Moderate: slope
Nash: 28	Slight	Slight	Moderate: slope
29	Slight	Slight	Severe: slope
¹ 30: Nash part	Slight	Slight	Moderate: slope
Lucien part	Slight	Slight	Severe: depth to rock
Noble: 31	Slight	Slight	Moderate: slope
¹ 32: Noble part	Slight	Slight	Moderate: slope
Darnell part	Slight	Slight	Severe: depth to rock, slope.
Norge: 33	Moderate: percs slowly	Slight	Moderate: percs slowly
34, 35	Moderate: percs slowly	Slight	Moderate: percs slowly, slope.
Pocasset: 36	Severe: floods	Moderate: floods, too clayey.	Moderate: floods, too clayey.
Pond Creek: 37	Moderate: percs slowly	Slight	Moderate: percs slowly
38	Moderate: percs slowly	Slight	Moderate: percs slowly, slope.

TABLE 9.- *Soil ratings for recreational development—Continued*

Soil name and map symbols	Camp areas	Picnic areas	Paths and trails
Port: 39, 40	Severe: floods	Moderate: floods	Moderate: floods
Pulaski: 41	Severe: floods	Moderate: floods	Moderate: floods
Quinlan: 42; Quinlan part	Severe: slope	Severe: slope	Severe: depth to rock
Rock outcrop part.			
Reinach: 43	Severe: floods	Moderate: floods	Moderate: floods
Renfrow: 44, 45, 46	Severe: percs slowly	Slight	Severe: slope, percs slowly.
147: Renfrow part	Severe: percs slowly	Slight	Severe: slope, percs slowly.
Hinkle part	Severe: percs slowly	Slight	Severe: percs slowly
Stephenville: 48, 49, 50, 51	Slight	Slight	Moderate: slope
152: Stephenville part	Slight	Slight	Moderate: slope
Darnell part	Slight	Slight	Severe: depth to rock, slope.
153: Stephenville part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy, slope.
Eufaula part	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy
154: Stephenville part	Slight	Slight	Severe: slope
Pulaski part	Severe: floods	Severe: floods	Severe: floods
Teller: 55, 56, 57	Slight	Slight	Moderate: slope
58	Slight	Slight	Severe: slope
Tivoli: 59	Severe: too sandy, dusty	Severe: too sandy, dusty	Severe: too sandy, dusty
Windthorst: 60	Moderate: percs slowly	Slight	Moderate: percs slowly
61	Moderate: percs slowly	Slight	Moderate: percs slowly

Yahola: 62 -----	Severe: floods -----	Moderate: floods -----	Moderate: floods -----
Zaneis: 63, 64, 65, 66 -----	Moderate: percs slowly --	Slight -----	Moderate: percs slowly, slope.

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and mapping unit.

TABLE 10.—*Soil ratings for wildlife habitat*

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements						Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land wildlife	Wetland wildlife	Range-land wildlife
Amber: 1 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Bethany: 2 -----	Good ---	Good ---	Fair ----	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
Cyril: 3 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Dale: 4 -----	Good ---	Good ---	Fair ----	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Fair.
Darnell: ¹ 5: Darnell part -----	Poor ----	Poor ----	Fair ----	Fair ----	Very poor.	Very poor.	Poor ----	Very poor.	Fair.
Noble part -----	Fair ----	Good ---	Good ---	Good ---	Very poor.	Very poor.	Good ---	Very poor.	Good.
Dougherty: 6 -----	Fair ----	Fair ----	Good ---	Good ---	Poor ----	Very poor.	Fair ----	Very poor.	Good.
¹ 7: Dougherty part -----	Fair ----	Fair ----	Good ---	Good ---	Poor ----	Very poor.	Fair ----	Very poor.	Good.
Eufaula part -----	Fair ----	Fair ----	Fair ----	Good ---	Very poor.	Very poor.	Fair ----	Very poor.	Fair.
Eufaula: 8 -----	Fair ----	Fair ----	Fair ----	Good ---	Very poor.	Very poor.	Fair ----	Very poor.	Fair.
¹ 9: Eufaula part -----	Fair ----	Fair ----	Fair ----	Good ---	Very poor.	Very poor.	Fair ----	Very poor.	Fair.
Stephenville part -----	Fair ----	Fair ----	Good ---	Good ---	Very poor.	Very poor.	Fair ----	Very poor.	Good.
Gracemont: 10 -----	Fair ----	Good ---	Good ---	Good ---	Fair ----	Poor ----	Good ---	Poor ----	Good.
Gracemore: ¹ 11 -----	Poor ----	Fair ----	Fair ----	Good ---	Fair ----	Poor ----	Fair ----	Poor ----	Good.
Grant: 12, 13, 14 -----	Good ---	Good ---	Good ---	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
¹ 15: Grant part -----	Good ---	Good ---	Good ---	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
Port part -----	Poor ----	Fair ----	Fair ----	Good ---	Poor ----	Very poor.	Fair ----	Very poor.	Fair.
Keokuk: 16 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.

TABLE 10.—*Soil ratings for wildlife habitat*—Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land wildlife	Wetland wildlife	Range-land wildlife
Kirkland: 17 -----	Good ---	Good ---	Good ---	Fair ---	Poor ---	Very poor.	Good ---	Very poor.	Fair.
Konawa: 18 -----	Fair ---	Fair ---	Good ---	Good ---	Poor ---	Very poor.	Fair ---	Very poor.	Good.
¹ 19: Konawa part -----	Fair ---	Fair ---	Good ---	Good ---	Poor ---	Very poor.	Fair ---	Very poor.	Good.
Stephenville part -----	Fair ---	Good ---	Good ---	Good ---	Poor ---	Very poor.	Good ---	Very poor.	Good.
Lela: 20 -----	Fair ---	Fair ---	Fair ---	Good ---	Poor ---	Fair ---	Fair ---	Poor ---	Good.
Lucien: ¹ 21: Lucien part -----	Poor ---	Fair ---	Fair ---	Fair ---	Poor ---	Very poor.	Fair ---	Very poor.	Fair.
Nash part -----	Fair ---	Good ---	Good ---	Fair ---	Very poor.	Very poor.	Good ---	Very poor.	Fair.
McLain: 22 -----	Good ---	Good ---	Fair ---	Fair ---	Good ---	Good ---	Good ---	Good ---	Fair.
Minco: 23 -----	Fair ---	Good ---	Good ---	Good ---	Poor ---	Very poor.	Good ---	Very poor.	Good.
24 -----	Poor ---	Fair ---	Good ---	Fair ---	Very poor.	Very poor.	Fair ---	Very poor.	Fair.
25, 26, 27 -----	Good ---	Good ---	Good ---	Good ---	Poor ---	Very poor.	Good ---	Very poor.	Good.
Nash: 28, 29 -----	Fair ---	Good ---	Good ---	Fair ---	Poor ---	Very poor.	Good ---	Very poor.	Fair.
¹ 30: Nash part -----	Fair ---	Good ---	Good ---	Fair ---	Poor ---	Very poor.	Good ---	Very poor.	Fair.
Lucien part -----	Poor ---	Fair ---	Fair ---	Fair ---	Poor ---	Very poor.	Fair ---	Very poor.	Fair.
Noble: 31 -----	Good ---	Good ---	Good ---	Good ---	Poor ---	Very poor.	Good ---	Very poor.	Good.
¹ 32: Noble part -----	Good ---	Good ---	Good ---	Good ---	Poor ---	Very poor.	Good ---	Very poor.	Good.
Darnell part -----	Poor ---	Poor ---	Fair ---	Fair ---	Very poor.	Very poor.	Poor ---	Very poor.	Fair.
Norge: 33, 34, 35 -----	Good ---	Good ---	Fair ---	Fair ---	Poor ---	Very poor.	Good ---	Very poor.	Fair.
Pocasset: 36 -----	Good ---	Good ---	Fair ---	Good ---	Poor ---	Very poor.	Good ---	Very poor.	Fair.

TABLE 10.—*Soil ratings for wildlife habitat*—Continued

Soil name and map symbol	Potential for habitat elements						Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land wildlife	Wetland wildlife	Range-land wildlife
Pond Creek: 37, 38 -----	Good ---	Good ---	Fair ----	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
Port: 39, 40 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Pulaski: 41 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Quinlan: ¹ 42: Quinlan part -----	Poor ----	Poor ----	Fair ----	Poor ----	Very poor.	Very poor.	Fair ----	Very poor.	Poor.
Rock outcrop part -----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Reinach: 43 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Renfrow: 44, 45, 46 -----	Good ---	Good ---	Good ---	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
¹ 47: Renfrow part -----	Good ---	Good ---	Good ---	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
Hinkle part -----	Poor ----	Poor ----	Very poor.	-----	Very poor.	Poor ----	Poor ----	Very poor.	Very poor.
Stephenville: 48, 49, 50 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
51 -----	Fair ----	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
¹ 52: Stephenville part -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Darnell part -----	Poor ----	Poor ----	Fair ----	Fair ----	Very poor.	Very poor.	Poor ----	Very poor.	Fair.
¹ 53: Stephenville part -----	Fair ----	Fair ----	Good ---	Good ---	Poor ----	Very poor.	Fair ----	Very poor.	Good.
Eufaula part -----	Fair ----	Fair ----	Fair ----	Good ---	Very poor.	Very poor.	Fair ----	Very poor.	Fair.
¹ 54: Stephenville part -----	Fair ----	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Pulaski part -----	Poor ----	Fair ----	Fair ----	Good ---	Poor ----	Very poor.	Fair ----	Very poor.	Fair.
Teller: 55, 56, 57, 58 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.

TABLE 10.—*Soil ratings for wildlife habitat—Continued*

Soil name and map symbol	Potential for habitat elements						Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land wildlife	Wetland wildlife	Range-land wildlife
Tivoli: 59 -----	Poor ----	Poor ----	Fair ----	Poor ----	Very poor.	Very poor.	Poor ----	Very poor.	Poor.
Windthorst: 60 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
61 -----	Fair ----	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Yahola: 62 -----	Good ---	Good ---	Good ---	Good ---	Poor ----	Very poor.	Good ---	Very poor.	Good.
Zaneis: 63, 64, 65 -----	Good ---	Good ---	Good ---	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.
66 -----	Fair ----	Good ---	Good ---	Fair ----	Poor ----	Very poor.	Good ---	Very poor.	Fair.

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

tained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, sorghum, wheat, oats, barley, millet, buckwheat, cowpeas, soybeans, and sunflowers. The major soil properties that affect the growth of grain and seed crops are depth to the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, lovegrass, switchgrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch. Major soil properties that affect the growth of grasses and legumes are depth to the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, indiangrass, goldenrod, beggarweed, pokeweed, partridgepea, wheatgrass, fescue, and grama. Major soil properties that affect the growth of these plants are depth to the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are coralberry, sumac, briars, skunkbush, roughleaf dogwood, huckleberry, sandplum, and big sagebrush. Major soil properties that affect the growth of shrubs are depth to the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, wild millet, rushes, sedges, reeds, wildrice, saltgrass, cordgrass, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife

watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of croplands, pastures, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Wildlife attracted to this habitat are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Wildlife attracted to this habitat are antelope, whitetailed deer, prairie chicken, bobwhite quail, scaled quail, coyote, meadowlark, and lark bunting.

Soil Properties

Extensive data about soil properties collected during the soil survey are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of samples selected from representative soil profiles in the field.

When he makes soil borings during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition, or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH or reaction, and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from laboratory analyses, both physical and chemical, are presented.

Engineering properties

Table 11 gives estimates of engineering properties

and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series under the heading "Soil Series."

Texture is described in table 11 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms used by USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified (2) Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (1) Soil Classification System (AASHTO). In table 11 soils in the survey area are classified according to both systems.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified as one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified as A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or more for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 14. The estimated classification, without group index numbers, is given in table 11. Also in table 11 the percentage, by weight, of cobbles or the rock fragments more than 3 inches in

diameter is estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of soil. These indexes are used in both the Unified and the AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior.

Ranges in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

Physical and chemical properties

Table 12 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the risk of corrosion of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields

is largely affected by the quality of the irrigation water and the irrigation practices. Hence, the salinity of individual fields can differ greatly from the value given in table 12. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 12, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Soil and water features

Features that relate to runoff or infiltration of water, to flooding, and to grading and excavation are indicated in table 13. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table, and by the presence of bedrock or a cemented pan in the upper 5 or 6 feet of the soil.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to a water table, water intake rate and permeability, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely. The ratings are based on evidences in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as Fluvents at the suborder

TABLE 11.—*Estimated engineering properties and classifications*

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated.]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments >3 inches	Percentage passing sieve number—		
			Unified	AASHTO		4	10	40
<i>I_a</i>					<i>P_{ct}</i>			
Amber: 1	0-36	Very fine sandy loam	CL, ML, CL-ML	A-4	0	100	100	94-100
	36-72	Very fine sandy loam, fine sandy loam, loamy fine sand.	CL, ML, SC, SM	A-2, A-4	0	100	98-100	90-100
Bethany: 2	0-14	Silt loam	CL, ML	A-4, A-6	0	100	100	96-100
	14-24	Silty clay loam,	CL	A-6, A-7	0	100	100	96-100
	24-64	Silty clay, clay	CL, CH	A-7	0	100	95-100	96-100
Cyril: 3	0-72	Fine sandy loam, loam	SM, SC, CL, ML	A-4	0	100	98-100	94-100
Dale: 4	0-44	Silt loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100
	44-60	Silt loam, silty clay loam, very fine sandy loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100
Darnell: 5	0-7	Fine sandy loam	SM, SC, ML, CL	A-4	0-5	90-100	90-100	85-100
	7-16	Fine sandy loam	SM, SC, CL-ML	A-4	0-8	70-100	70-100	60-100
	16-20	Weathered bedrock.						
	0-72	Fine sandy loam, loam	ML, CL, SM, SC	A-4	0	100	98-100	94-100
Dougherty: 6	0-30	Fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	82-98
	30-48	Fine sandy loam, sandy clay loam.	ML, SM, CL, SC	A-4, A-6	0	100	98-100	90-100
	48-72	Fine sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	100	98-100	90-100
Dougherty part 7	0-27	Fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	82-98
	27-48	Fine sandy loam, sandy clay loam.	ML, SM, CL, SC	A-4, A-6	0	100	98-100	90-100
	48-70	Fine sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	100	98-100	90-100
Eufaula part	0-80	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100

Eufaula: 8	0-72	Fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	82-100
	0-80	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100
	0-15 15-38 38-40	Loamy fine sand Fine sandy loam, sandy clay loam. Weathered bedrock.	SM SC, CL	A-2 A-4, A-6	0 0	100 100	98-100 98-100	90-100 90-100
Gracemont: 10	0-10	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4	0	100	98-100	94-100
	10-28	Fine sandy loam, loam	ML, CL-ML, SM-SC	A-4	0	100	98-100	94-100
	28-72	Fine sandy loam, loam	ML, CL-ML, SM, SM-SC	A-4	0	100	98-100	94-100
Gracemore: 11	0-10	Fine sand, loam, fine sandy loam, very fine sandy loam, loamy fine sand.	ML, SM, SP-SM	A-2, A-3, A-4	0	100	98-100	82-100
	10-72	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100
	0-12 12-50 50-72	Silt loam Silt loam, silty clay loam. Weathered bedrock.	ML, CL ML, CL	A-4, A-6 A-4, A-6, A-7	0 0	100 100	100 100	90-100 90-100
14	0-6 6-46 46-72	Silt loam Silt loam, silty clay loam. Weathered bedrock.	ML, CL ML, CL	A-4, A-6 A-4, A-6, A-7	0 0	100 100	100 100	90-100 90-100
	0-8 8-45 45-72	Silt loam Silt loam, silty clay loam. Weathered bedrock.	ML, CL ML, CL	A-4, A-6 A-4, A-6, A-7	0 0	100 100	100 100	90-100 90-100
	0-27 27-72	Silt loam Silty clay loam, silt loam.	ML, CL ML, CL	A-4, A-6 A-4, A-6, A-7	0 0	100 100	100 100	96-100 96-100
Keokuk: 16	0-60	Very fine sandy loam	ML, CL, CL-ML	A-4	0	100	100	94-100
	0-10 10-42 42-72	Silt loam Silty clay, clay Clay, silty clay	CL, ML CL, CH, MH CL, CH, MH	A-4, A-6 A-7 A-7	0 0 0	100 100 100	100 100 100	96-100 96-100 96-100
Kirkland: 17								

TABLE 11.—Estimated engineering properties and classifications—Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments >3 inches	Percentage passing sieve number—		
			Unified	AASHTO		4	10	40
Konawa: 18	<i>I_n</i>				<i>Pct</i>			
	0-12	Loamy fine sand	SM	A-2	0	98-100	98-100	90-100
	12-44	Fine sandy loam, sandy clay loam.	SC, CL	A-4, A-6	0	98-100	98-100	85-100
	44-85	Loamy fine sand, fine sandy loam, sandy clay loam.	SM, SC, CL, ML	A-2, A-4	0	98-100	98-100	85-100
^a 19: Konawa part	0-10	Loamy fine sand	SM	A-2	0	98-100	98-100	90-100
	10-24	Sandy clay loam, fine sandy loam.	SC, CL	A-4, A-6	0	98-100	98-100	85-100
	24-70	Fine sandy loam, sandy clay loam, loamy fine sand.	SM, SC, CL, ML	A-2, A-4, A-6	0	98-100	98-100	85-100
	0-5	Fine sandy loam	SM, SC, ML, CL	A-4	0	100	98-100	94-100
Stephenville part	5-36	Fine sandy loam, sandy clay loam.	SC, CL	A-4, A-6	0	100	98-100	90-100
	36-40	Weathered bedrock.						
Lela: 20	0-16	Silty clay	CL, MH, CH	A-7	0	100	100	96-100
	16-75	Silty clay, clay	CL, MH, CH	A-7	0	100	100	96-100
Lucien: ^a 21: Lucien part	0-7	Silt loam	ML, CL-ML	A-4	0	95-100	90-100	85-100
	7-18	Loam, very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	90-100	85-100	80-100
	18-24	Weathered bedrock.						
Nash part	0-26	Silt loam	ML, CL, CL-ML	A-4	0	100	95-100	85-100
	26-40	Weathered bedrock.						
McLain: 22	0-11	Silty clay loam	CL, ML	A-6, A-7	0	100	100	96-100
	11-50	Silty clay loam, silty clay.	CH, MH	A-6, A-7	0	100	100	96-100
	50-60	Silt loam, silty clay loam, silty clay.	CL, ML, CH, CL-ML	A-4, A-6, A-7	0	100	95-100	95-100
Minco: 23, 24	0-42	Very fine sandy loam	ML, CL-ML	A-4	0	100	100	94-100
	42-72	Silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	94-100
25, 26, 27	0-38	Silt loam	ML, CL-ML	A-4	0	100	100	94-100
	38-72	Silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	94-100

Nash: 28, 29 -----	0-34 34-40	Loam, very fine sandy loam. Weathered bedrock.	ML, CL, CL-ML	A-4	0	100	100	94-100
Nash: a 30: Nash part -----	0-28 28-40	Loam ----- Weathered bedrock.	CL-ML, ML, CL	A-4	0	100	100	94-100
Lucien part -----	0-7 7-18 18-30	Silt loam ----- Loam, silt loam, fine sandy loam. Weathered bedrock.	CL-ML, CL ML, CL, CL-ML	A-4 A-4	0 0	100 100	100 100	96-100 94-100
Noble: 31 -----	0-65	Fine sandy loam -----	ML, CL, SM, SC	A-4	0	100	98-100	94-100
a 32: Noble part -----	0-72	Fine sandy loam -----	ML, CL, SM, SC	A-4	0	100	98-100	94-100
Darnell part -----	0-5	Fine sandy loam -----	SM, SC, ML, CL	A-4	0-5	90-100	90-100	85-100
	5-17 17-30	Fine sandy loam ----- Weathered bedrock.	SM, SC, ML, CL	A-4	0-8	70-100	70-100	60-100
Norge: 33, 34, 35 -----	0-16 16-64	Silty clay loam ----- Silty clay loam, clay loam.	ML, CL CL	A-4, A-6 A-6, A-7	0 0	100 100	100 100	96-100 96-100
Pocasset: 36 -----	0-14 14-72	Silty clay loam ----- Fine sandy loam, loamy fine sand.	CL SC, SM, CL, ML	A-6, A-7 A-2, A-4	0 0	100 100	100 98-100	98-100 90-100
Pond Creek: 37, 38 -----	0-12 12-72	Silt loam ----- Silty clay loam, clay loam, silt loam.	ML, CL, CL-ML CL, ML	A-4, A-6 A-4, A-6, A-7	0 0	100 100	100 100	96-100 96-100
Port: 39 -----	0-14 14-72	Fine sandy loam ----- Silty clay loam, silt loam, loam.	SM, SM-SC, CL-ML, ML, CL	A-4 A-4, A-6, A-7	0 0	100 100	98-100 100	94-100 96-100
40 -----	0-27 27-72	Silt loam ----- Silty clay loam, silt loam.	ML, CL ML, CL	A-4, A-6 A-4, A-6, A-7	0	100	100	96-100
Pulaski: 41 -----	0-10 10-60	Fine sandy loam ----- Fine sandy loam, loam -----	SM-SC, CL-ML, ML SM, SM-SC, ML, CL-ML	A-4 A-4	0 0	100 100	95-100 95-100	90-100 90-100

TABLE 11.—*Estimated engineering properties and classifications—Continued*

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number—		
			Unified	AASHTO		4	10	40
<i>I_n</i>					<i>Pet</i>			
Quinlan: ^{a 42:} Quinlan. part Rock outcrop part.	0-14 14-30	Loam, silt loam Weathered bedrock.	CL, CL-ML	A-4	0	100	95-100	90-100
Reinach: ⁴³	0-84	Silt loam, very fine sandy loam.	CL, ML, CL-ML	A-4	0	100	100	94-100
Renfrow: 44, 45, 46	0-9 9-15 15-65	Silt loam Silty clay loam Clay, silty clay	ML, CL CL, CH CL, CH	A-4, A-6 A-6, A-7 A-7	0 0 0	100 100 100	100 100 100	96-100 96-100 96-100
^{a 47:} Renfrow part	0-7 7-12 12-72	Silt loam Clay loam, silty clay loam. Clay, silty clay	ML, CL CL CL, CH	A-4, A-6 A-6, A-7 A-7	0 0 0	100 100 100	100 100 100	96-100 96-100 96-100
Hinkle part	0-6 6-42 42-45	Silt loam Clay loam, silty clay loam, silty clay. Weathered bedrock.	CL, ML CL, CH	A-4, A-6 A-7	0 0	100 100	100 100	94-100 96-100
Stephenville: 48, 49, 50, 51	0-10 10-38 38-45	Fine sandy loam Fine sandy loam, sandy clay loam. Weathered bedrock.	SM, SC, ML, CL SC, CL	A-4 A-4, A-6	0 0	100 100	98-100 98-100	94-100 90-100
^{a 52:} Stephenville part	0-10 10-38 38-40	Fine sandy loam Fine sandy loam, sandy clay loam. Weathered bedrock.	SM, SC, ML, CL SC, CL	A-4 A-4, A-6	0 0	100 100	98-100 98-100	94-100 90-100
Darnell part	0-5 5-17 17-30	Fine sandy loam Fine sandy loam, loam Weathered bedrock.	SM, SC, ML, CL SM, SC, ML, CL	A-4 A-4	0-5 0-8	90-100 70-100	90-100 70-100	85-100 60-100
^{a 53:} Stephenville part	0-14 14-30 30-40	Loamy fine sand Fine sandy loam, sandy clay loam. Weathered bedrock.	SM SC, CL	A-2 A-4, A-6	0 0	100 100	98-100 98-100	90-100 90-100
Eufaula part	0-80	Loamy fine sand	SM	A-2	0	100	98-100	90-100

^a 54:

Stephenville part -----

0-11 Fine sandy loam -----
11-38 Fine sandy loam, sandy
38-40 clay loam.
Weathered bedrock.

Pulaski part -----

0-12 Fine sandy loam -----
12-64 Fine sandy loam, loam -----

Teller:

55, 56, 57, 58 -----

0-16 Loam -----
16-46 Sandy clay loam,
46-72 clay loam.
Fine sandy loam, very
fine sandy loam, loam.

Tivoli:

59 -----

0-10 Loamy fine sand -----
10-60 Fine sand -----

Windthorst:

60, 61 -----

0-10 Fine sandy loam -----
10-46 Clay, sandy clay,
46-52 clay loam.
Clay, sandy clay,
52-60 clay loam.
Stratified variable.

Yahola:

62 -----

0-10 Fine sandy loam -----
10-60 Fine sandy loam -----

Zaneis:

63, 64, 65, 66 -----

0-13 Loam -----
13-44 Clay loam, sandy
44-50 clay loam.
Clay loam, sandy
50-58 clay loam.
Weathered bedrock.

¹ Nonplastic.

² This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and ping unit.

A-4	SM, SC, ML, CL SC, CL		0	100	98-100	94-100
A-4, A-6			0	100	98-100	90-100
A-4	SM, SC, ML, CL		0	100	95-100	90-100
A-4	SM, SC, ML, CL		0	100	95-100	90-100
A-4	CL-ML, ML, CL SC, CL		0	100	100	94-100
A-6, A-4			0	100	100	90-100
A-4, A-6	SM, SC, ML, CL		0	100	100	94-100
A-2 A-2, A-3	SM SM, SP-SM		0 0	100 100	98-100 98-100	90-100 80-98
A-4	SM, SM-SC, CL-ML, CL, CH		0	95-100	90-100	75-100
A-6, A-7			0	95-100	95-100	85-100
A-6, A-7	CL, CH		0	85-100	80-100	75-100
A-4	SM-SC, CL-ML, ML		0	100	95-100	90-100
A-4	SM, ML, SM-SC, CL-ML		0	100	95-100	90-100
A-4	CL-ML, ML SC, CL		0	100	100	96-100
A-4, A-6			0	100	100	90-100
A-4, A-6	SC, CL		0-7	90-100	90-100	85-100

TABLE 12.—*Estimated physical and chemical properties*

[Dashes indicate data were not available. The symbol < means less than; > means greater than. The erosion tolerance factor file. Absence of an entry means data were not estimated.]

Soil name and map symbol	Depth <i>I</i> _n	Perme- ability <i>I</i> _n / <i>hr</i>	Available water capacity <i>I</i> _n / <i>in</i>	Soil reaction <i>pH</i>	Salinity <i>Mmbos/cm</i>	Shrink- swell potential	Risk of corrosion	
							Uncoated steel	Concrete
Amber: 1	0-36 36-72	0.6-2.0 0.6-2.0	0.13-0.20 0.07-0.20	6.1-8.4 7.9-8.4	<2 <2	Low Low	Low Low	Low Low
Bethany: 2	0-14 14-24 24-64	0.6-2.0 0.20-0.60 0.06-0.20	0.18-0.22 0.16-0.20 0.14-0.18	5.6-7.3 6.1-7.3 7.4-8.4	<2 <2 <2	Low Moderate High	Low Moderate High	Low Low Low
Cyril: 3	0-72	0.60-2.0	0.11-0.17	7.4-8.4	<2	Low	Low	Low
Dale: 4	0-44 44-60	0.6-2.0 0.6-2.0	0.15-0.24 0.15-0.24	6.1-8.4 7.4-8.4	<2 <2	Moderate Moderate	Moderate Moderate	Low Low
Darnell: 5	0-7 7-16 16-20	2.0-6.0 2.0-6.0	0.12-0.16 0.12-0.16	5.6-6.5 5.6-7.3	<2 <2	Low Low	Low Low	Moderate Moderate
Noble part	0-72	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low	Low	Low
Dougherty: 6	0-30 30-48 48-72	2.0-6.0 0.6-2.0 0.6-2.0	0.05-0.08 0.11-0.17 0.11-0.17	5.6-7.3 5.6-7.3 5.6-7.3	<2 <2 <2	Low Low Low	Low Low Low	Moderate Moderate Moderate
17: Dougherty part	0-27 27-48 48-70	2.0-6.0 0.6-2.0 0.6-2.0	0.05-0.08 0.11-0.17 0.11-0.17	5.6-7.3 5.6-7.3 5.6-7.3	<2 <2 <2	Low Low Low	Low Low Low	Moderate Moderate Moderate
Eufaula part	0-80	6.0-20.0	0.05-0.11	5.6-7.3	<2	Low	Low	Moderate
Eufaula: 8	0-72	6.0-20.0	0.05-0.11	5.6-7.3	<2	Low	Low	Moderate
19: Eufaula part	0-80	6.0-20.0	0.05-0.11	5.6-7.3	<2	Low	Low	Moderate
Stephenville part	0-15 15-38 38-40	2.0-6.0 0.6-2.0	0.07-0.11 0.11-0.17	5.6-6.5 5.1-6.0	<2 <2	Low Low	Low Moderate	Moderate Moderate
Gracemont: 10	0-10 10-28 28-72	2.0-6.0 2.0-6.0 0.6-6.0	0.11-0.20 0.11-0.20 0.11-0.20	6.6-8.4 7.9-8.4 7.9-8.4	<2 0-2 0-2	Low Low Low	Low Moderate Moderate	Moderate Low Low

Gracemore: ¹ 11	0-10 10-72	2.0-6.0 2.0-6.0	0.05-0.11 0.05-0.11	7.4-8.4 7.4-8.4	<2 <2	Low Low	Low Low
Grant: 12, 13, 14	0-12 12-50 50-72	0.6-6.0 0.6-2.0	0.15-0.20 0.15-0.20	6.1-7.3 6.1-7.8	<2 <2	Low Low	Low Low
¹ 15: Grant part	0-8 8-45 45-72	0.6-6.0 0.6-2.0	0.15-0.20 0.15-0.20	6.1-7.3 6.1-7.8	<2 <2	Low Low	Low Low
Port part	0-20 20-72	0.6-2.0 0.6-2.0	0.15-0.24 0.15-0.24	6.1-7.8 6.6-8.4	<2 <2	Moderate Moderate	Moderate Moderate
Keokuk: ¹ 16	0-60	0.6-2.0	0.15-0.20	6.6-8.4	<2	Low	Low
Kirkland: ¹ 17	0-10 10-42 42-72	0.6-2.0 <0.06 0.6-0.20	0.15-0.24 0.12-0.18 0.12-0.22	6.1-7.3 6.6-7.8 7.4-8.4	<2 <2 <2	Low High High	Low Low. Low.
Konawa: ¹ 18	0-12 12-44 44-85	0.6-2.0 2.0-6.0 6.0-20.0	0.12-0.16 0.11-0.15 0.07-0.11	5.6-6.5 5.6-6.5 5.6-7.3	<2 <2 <2	Low Low Low	Moderate. Moderate. Moderate.
¹ 19: Konawa part	0-10 10-24 24-70	6.0-20.0 0.6-2.0 2.0-6.0	0.06-0.10 0.12-0.16 0.07-0.15	5.6-6.5 5.6-6.5 5.6-7.3	<2 <2 <2	Low Low Low	Moderate Moderate. Moderate.
Stephenville part	0-5 5-36 36-40	2.0-6.0 0.6-2.0	0.11-0.15 0.11-0.17	5.6-6.5 5.1-6.0	<2 <2	Low Low	Moderate. Moderate.
Lela: ¹ 20	0-16 16-75	<0.06 <0.06	0.12-0.22 0.12-0.18	6.6-7.8 7.4-8.4	<2 <2	High High	Low Low.
Lucien: ¹ 21: Lucien part	0-7 7-18 18-24	2.0-6.0 2.0-6.0	0.10-0.24 0.10-0.24	6.1-7.3 6.1-7.3	<2 <2	Low Low	Low Low.
Nash part	0-26 26-40	0.6-2.0	0.13-0.24	6.1-8.4	<2	Low	Low
McLain: ¹ 22	0-11 11-50 50-60	0.2-0.6 0.06-0.6 0.06-0.6	0.15-0.22 0.12-0.24 0.12-0.24	6.1-7.3 6.6-8.4 6.6-8.4	<2	Moderate High High	Low. Low. Low.
Minco: 23, 24, 25, 26, 27	0-42 42-72	0.6-2.0 0.6-2.0	0.13-0.24 0.11-0.24	5.6-7.3 6.1-8.4	<2 <2	Low Low	Low Low.
Nash: 28, 29	0-34 34-40	0.6-2.0	0.13-0.24	6.1-8.4	<2	Low	Low

TABLE 12.—*Estimated physical and chemical properties—Continued*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion	
							Uncoated steel	Concrete
	<i>I_n</i>	<i>I_n/hr</i>	<i>I_n/in</i>	<i>pH</i>	<i>Mmhos/cm</i>			
¹ 30: Nash part	0-28 28-40	0.6-2.0	0.13-0.24	6.1-8.4	<2	Low	Low	Low
Lucien part	0-7 7-18 18-30	2.0-6.0 2.0-6.0	0.10-0.24 0.10-0.24	6.1-7.3 6.1-7.3	<2 <2	Low Low	Low Low	Low Low.
Noble: 31	0-65	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low	Low	Low
¹ 32: Noble part	0-72	2.0-6.0	0.11-0.17	5.6-7.3	<2	Low	Low	Low
Darnell part	0-5 5-17 17-30	2.0-6.0 2.0-6.0	0.12-0.16 0.12-0.16	5.6-6.5 5.6-7.3	<2 <2	Low Low	Low Low	Moderate Moderate.
Norge: 33, 34, 35	0-16 16-64	0.6-2.0 0.2-0.6	0.15-0.24 0.15-0.22	5.6-7.3 5.6-8.4	<2 <2	Low Moderate	Moderate Moderate	Low Low.
Pocasset: 36	0-14 14-40 40-72	0.6-2.0 2.0-6.0 2.0-6.0	0.18-0.22 0.11-0.15 0.07-0.15	6.6-8.4 7.9-8.4 7.9-8.4	<2 <2 <2	Moderate Low Low	Moderate Low Low	Low. Low. Low.
Pond Creek: 37, 38	0-12 12-72	0.6-2.0 0.2-0.6	0.15-0.20 0.15-0.22	5.6-7.3 6.1-8.4	<2 <2	Low Moderate	Low Moderate	Low Moderate
Port: 39	0-14 14-72	0.6-2.0 0.6-2.0	0.11-0.20 0.15-0.24	6.1-7.8 6.6-8.4	<2 <2	Low Moderate	Low Moderate	Low Low.
40	0-27 27-72	0.6-2.0 0.6-2.0	0.15-0.24 0.15-0.24	6.1-7.8 6.6-8.4	<2 <2	Moderate Moderate	Moderate Moderate	Low Low.
Pulaski: 41	0-10 10-60	2.0-6.0 2.0-6.0	0.12-0.16 0.12-0.16	5.6-7.3 5.6-7.3	<2 <2	Low Low	Low Low	Moderate. Moderate.
Quinlan: ¹ 42: Quinlan part	0-14 14-30	2.0-6.0	0.15-0.20	7.4-8.4	<2	Low	Low	Low
Rock outcrop part.								
Reinach: 43	0-84	0.6-2.0	0.13-0.24	6.1-8.4	<2	Low	Low	Low

Renfrow: 44, 45, 46	0-9 9-15 15-65	0.6-2.0 0.2-0.6 <0.06	0.15-0.24 0.15-0.22 0.12-0.22	6.1-7.3 6.1-7.8 6.1-8.4	<2 <2 <2	Low Moderate High	Low Moderate High	Low Low. Low.
¹ 47: Renfrow part	0-7 7-12 12-75	0.6-2.0 0.2-0.6 <0.06	0.15-0.24 0.15-0.22 0.12-0.22	6.1-7.3 6.1-7.8 6.1-8.4	<2 <2 <2	Low Moderate High	Low Moderate High	Low Low. Low.
Hinkle part	0-6 6-42 42-45	0.6-2.0 <0.06	0.15-0.24 0.09-0.17	6.1-8.4 6.6-8.4	<2 2-6	Low High High	High High High	High. High. High.
Stephenville: 48, 49, 50, 51	0-10 10-38 38-45	2.0-6.0 0.6-2.0	0.11-0.15 0.11-0.17	5.6-7.3 5.6-6.0	<2 <2	Low Low	Low Moderate	Moderate. Moderate.
¹ 52: Stephenville part	0-10 10-38 38-40	2.0-6.0 0.6-2.0	0.11-0.15 0.11-0.17	5.6-6.5 5.1-6.0	<2 <2	Low Low	Low Moderate	Moderate. Moderate.
Darnell part	0-5 5-17 17-30	2.0-6.0 2.0-6.0	0.12-0.16 0.12-0.16	5.6-6.5 5.6-7.3	<2 <2	Low Low	Low Low	Moderate. Moderate.
¹ 53: Stephenville part	0-14 14-30 30-40	2.0-6.0 0.6-2.0	0.07-0.11 0.11-0.17	5.6-6.5 5.6-7.3	<2 <2	Low Low	Low Moderate	Moderate. Moderate.
Eufaula part	0-80	6.0-20.0	0.05-0.11	5.6-7.3	<2	Low	Low	Moderate
¹ 54: Stephenville part	0-11 11-38 38-40	2.0-6.0 0.6-2.0	0.11-0.15 0.11-0.17	5.6-6.5 5.6-7.3	<2 <2	Low Low	Low Moderate	Moderate. Moderate.
Pulaski part	0-12 12-64	2.0-6.0 2.0-6.0	0.12-0.16 0.12-0.16	5.6-7.3 5.6-7.3	<2 <2	Low Low	Low Low	Moderate. Moderate.
Teller: 55, 56, 57, 58	0-16 16-46 46-72	2.0-6.0 0.6-2.0 2.0-6.0	0.12-0.16 0.14-0.18 0.13-0.17	5.6-6.5 5.6-6.5 5.6-7.3	<2 <2 <2	Low Low Low	Low Low Low	Moderate Moderate Moderate
Tivoli: 59	0-10 10-60	6.0-20.0 6.0-20.0	0.05-0.11 0.02-0.06	6.1-7.8 6.1-8.4	<2 <2	Low Low	Low Low	Low Low.
Windthorst: 60, 61	0-10 10-46 46-52 52-60	0.6-2.0 0.2-0.6 0.2-0.6	0.12-0.17 0.15-0.20 0.12-0.20	5.6-7.3 5.6-6.5 5.6-8.4	<2 <2 <2	Low Moderate Moderate	Low High Moderate	Low Low Low
Yahola: 62	0-10 10-60	2.0-6.0 2.0-6.0	0.12-0.16 0.07-0.16	7.9-8.4 7.9-8.4	<2 <2	Low Low	Low Low	Low Low.
Zaneis: 63, 64, 65, 66	0-13 13-44 44-50 50-58	0.6-2.0 0.2-0.6 0.2-2.0	0.11-0.20 0.12-0.20 0.11-0.20	5.6-7.3 5.6-7.3 6.1-7.8	<2 <2 <2	Low Moderate Moderate	Low Moderate Moderate	Low Low. Low.

¹ This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition mapping unit.

Konawa: 18	B	None				>6.0
¹ 19 Konawa part	B	None				>6.0
Stephenville part	B	None				>6.0
Lela: 20	D	Occasional	Very brief	Apr-Oct		>6.0
Lucien: ¹ 21:	C	None				>6.0
Lucien part	B	None				>6.0
Nash part	C	Rare	Very brief	Apr-Aug		>6.0
McLain: 22	B	None				>6.0
Minco: 23, 24, 25, 26, 27	B	None				>6.0
Nash: 28, 29	B	None				>6.0
¹ 30: Nash part	B	None				>6.0
Lucien part	C	None				>6.0
Noble: 31	B	None				>6.0
¹ 32: Noble part	B	None				>6.0
Darnell part	C	None				>6.0
Norge: 33, 34, 35	B	None				>6.0
Pocasset: 36	B	Occasional	Very brief	Mar-Aug		>6.0
Pond Creek: 37, 38	B	None				>6.0
Port: 39, 40	B	Common	Very brief to brief.	Mar-Aug		>6.0
Pulaski: 41	B	Common	Very brief	Mar-Aug		>6.0
Quinlan: ¹ 42:	C	None				>6.0
Quinlan part Rock outcrop part.	B	Rare	Very brief	Mar-Aug		>6.0
Reinach: 43	D	None				>6.0
Renfrow: 44, 45, 46						

TABLE 13.—*Soil and water features—Continued*

Soil name and map symbol	Hydro- logic group	Flooding			High water table		
		Frequency	Duration	Months	Depth	Kind	Month
¹ 47: Renfrow part -----	D	None -----			>6.0		
Hinkle part -----	D	None -----			>6.0		
Stephenville: 48, 49, 50, 51 -----	B	None -----			>6.0		
¹ 52: Stephenville part -----	B	None -----			>6.0		
Darnell part -----	C	None -----			>6.0		
¹ 53: Stephenville part -----	B	None -----			>6.0		
Eufaula part -----	A	None -----			>6.0		
¹ 54: Stephenville part -----	B	None -----			>6.0		
Pulaski part -----	B	Common -----	Very brief	Mar-Aug	>6.0		
Teller: 55, 56, 57, 58 -----	B	None -----			>6.0		
Tivoli: 59 -----	A	None -----			>6.0		
Windthorst: 60, 61 -----	C	None -----			>6.0		
Yahola: 62 -----	B	Common -----	Very brief	Mar-Aug	>6.0		
Zaneis: 63, 64, 65, 66 -----	B	None -----			>6.0		

¹ This mapping unit is made up of two or more dominant kinds of soils. See mapping unit description for the composition mapping unit.

level or as Fluventic subgroups. See the section "Classification."

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood prone areas at specific flood frequency levels.

A *seasonal high water table* is the highest level of a saturated zone more than 6 inches thick in soils for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the seasonal high water table, the kind of water table, and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, a limited range in depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and other observations during the soil mapping. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Soil test data

Table 14 contains engineering test data for some of the major soil series in Grady County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 11.

Shrinkage limit is the percentage of moisture at

which shrinkage of the soil material stops.

Shrinkage ratio is the relation of change in volume of the soil material to the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when oven dry.

Linear shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit.

Soil Series

On the following pages each soil series in the survey area is described in detail. The series descriptions are presented in alphabetic order by series name.

For each series, some facts about the soil and its parent material are presented first. Then a pedon, a small three dimensional area of soil typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (3). Unless otherwise noted, colors described are for dry soils.

Following the pedon description is the range of important characteristics of the soil series mapped in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil Maps for Detailed Planning."

Amber Series

The Amber series consists of deep, moderately permeable, very gently sloping, well drained soils on flood plains. These soils formed in loamy sediment under a cover of tall grasses and scattered oak and other hardwoods. They are subject to flooding.

Representative profile of Amber very fine sandy loam, 1 to 3 percent slopes, 3,000 feet north and 700 feet east of the southwest corner of sec. 25, T. 5 N., R. 5 W.

- Ap—0 to 12 inches; reddish brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; weak fine granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.
- B2—12 to 36 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak fine granular structure; slightly hard, friable; many fine roots; moderately alkaline; gradual smooth boundary.
- C—36 to 72 inches; reddish yellow (5YR 7/8) fine sandy loam, reddish yellow (5YR 6/8) moist; massive; slightly hard, very friable; common fine roots; thin strata of reddish yellow very fine sandy loam; few films and soft spots of secondary lime below 40 inches; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Thickness of the A horizon is less than 10 inches where color value and chroma are less than 3.5. The A horizon is reddish brown or yellowish red. It is slightly acid to mildly alkaline. The B2 horizon is reddish brown, yellowish red, or reddish yellow. It is mildly or moderately alkaline. The C horizon is light red, yellowish red, or reddish yellow very fine sandy loam, fine sandy loam, or loamy fine sand that contains thin strata of finer or coarser material. It is moderately alkaline and calcareous.

Bethany Series

The Bethany series consists of deep, slowly permeable, nearly level, well drained soils on uplands. These soils formed in material weathered from shale or in clayey sediment under a cover of tall grasses.

Representative profile of Bethany silt loam, 0 to 1 percent slopes, 660 feet north and 50 feet east of the southwest corner of sec. 28, T. 10 N., R. 7 W.

- A1—0 to 14 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.
- B1—14 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; strong fine subangular blocky structure; hard, firm; few fine black concretions; slightly acid; gradual smooth boundary.
- B21t—24 to 35 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, very firm; few fine black concretions; clay films on faces of peds; mildly alkaline; clear smooth boundary.
- B22t—35 to 52 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate coarse blocky structure; extremely hard, extremely firm; clay films on faces of peds; few fine iron concretions; mildly alkaline; gradual smooth boundary.
- B3—52 to 64 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; common coarse distinct brownish yellow (10YR 6/8) mottles; weak coarse blocky structure; very hard, very firm; few iron concretions; few calcium carbonate concretions; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A1 horizon is brown, dark brown, grayish brown, or dark grayish brown. It ranges from medium acid to neutral. The B1 horizon is brown, dark brown, grayish brown, or dark grayish brown clay loam or silty clay loam. It is slightly acid or neutral. The B2t horizon is brown, dark brown, grayish brown, dark grayish brown, yellowish brown, dark yellowish brown, or reddish brown clay or silty clay. It is mildly or moderately alkaline. In color and reaction, the B3 horizon is similar to the B2t horizon. The B3 horizon has common, coarse mottles of yellowish red, brownish yellow, or reddish brown.

Cyril Series

The Cyril series consists of deep, moderately permeable, nearly level, well drained soils on flood plains. These soils formed in loamy sediment under a cover of tall grasses and scattered bottom land hardwoods. They are subject to flooding.

Representative profile of Cyril fine sandy loam, 2,200 feet east and 420 feet south of the northwest corner of sec. 12, T. 3 N., R. 7 W.

- Ap—0 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; calcareous; moderately alkaline; gradual smooth boundary.
- A1—12 to 28 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable; few spots of soft calcium carbonate in the lower part; calcareous; moderately alkaline; gradual smooth boundary.
- B—28 to 50 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine granular structure; slightly hard, friable; common spots and threads of cal-

cium carbonate; calcareous; moderately alkaline; clear smooth boundary.

- C—50 to 72 inches; strong brown (7.5YR 5/6) fine sandy loam, strong brown (7.5YR 4/6) moist; massive; hard, friable; common spots and films of calcium carbonate; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Thickness of the A horizon ranges from 20 to 40 inches. The A horizon is gray, dark gray, very dark gray, grayish brown, dark grayish brown, or very dark grayish brown. It is mildly or moderately alkaline in the upper part and moderately alkaline in the lower part. A few pedons are noncalcareous in the upper 10 inches. The B horizon is brown, grayish brown, dark brown, dark yellowish brown, or strong brown fine sandy loam or loam. The C horizon is brown, light brown, strong brown, or light yellowish brown. It is mainly fine sandy loam or loam, but may be coarser or finer below a depth of 40 inches.

Dale Series

The Dale series consists of deep, moderately permeable, nearly level, well drained soils on flood plains. These soils formed in loamy sediment under a cover of tall grasses and scattered bottom land hardwoods. They are subject to flooding.

Representative profile of Dale silt loam, 1,320 feet east and 50 feet north of the southwest of sec. 23, T. 6 N., R. 6 W.

- A1—0 to 15 inches; dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.
- B21—15 to 34 inches; reddish brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; hard, firm; mildly alkaline; gradual smooth boundary.
- B22—34 to 44 inches; reddish brown (5YR 4/4) silt loam, dark reddish brown (5YR 3/4) moist; weak coarse subangular blocky structure; hard, friable; secondary carbonates at 36 inches; calcareous; moderately alkaline; gradual smooth boundary.
- C—44 to 60 inches; yellowish red (5YR 4/6) silty clay loam, yellowish red (5YR 3/6) moist; massive; slightly hard, very friable; common films and spots of calcium carbonate; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The mollic epipedon is 20 inches thick or more. Soft, powdery, secondary lime is within depths of 34 to 60 inches. The A1 horizon is dark brown, brown, dark grayish brown, or grayish brown. It is slightly acid to mildly alkaline. The B horizon is dark brown, brown, dark grayish brown, reddish brown, or grayish brown silt loam or silty clay loam. It is slightly acid to moderately alkaline. The C horizon is yellowish red, reddish brown, light reddish brown, or brown silt loam, very fine sandy loam, or silty clay loam. It is mildly or moderately alkaline and is calcareous.

Darnell Series

The Darnell series consists of shallow, moderately rapidly permeable, well drained to somewhat excessively drained, gently sloping to moderately steep soils on uplands. These soils formed in material weathered from sandstone under a cover of oak forest and an understory of tall grasses.

Representative profile of Darnell fine sandy loam in an area of Darnell-Noble complex, 8 to 20 percent slopes, 2,550 feet south and 100 feet east of the northwest corner of sec. 5, T. 9 N., R. 8 W.

- A1—0 to 7 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granu-

lar structure; slightly hard, very friable; slightly acid; clear smooth boundary.

B2—7 to 16 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; moderate fine granular structure; slightly hard, very friable; slightly acid; clear wavy boundary.

C—16 to 20 inches; red acid sandstone.

Depth to bedrock ranges from 10 to 20 inches. Depth to the water table is more than 6 feet. The A horizon is brown, reddish brown, dark grayish brown, or grayish brown. It is slightly acid or medium acid. The B2 horizon is brown, reddish brown, light reddish brown, or yellowish red. It is neutral to medium acid. The C horizon is rippable, reddish sandstone.

Dougherty Series

The Dougherty series consists of deep, moderately permeable, nearly level to sloping, well drained soils on uplands. These soils formed in sandy and loamy sediment under a cover of oak forest and an understory of tall grasses.

Representative profile of Dougherty fine sand, 0 to 3 percent slopes, 250 feet north and 350 feet east of the southwest corner of sec. 25, T. 3 N., R. 7 W.

A1—0 to 8 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; weak fine granular structure; soft, very friable; medium acid; gradual smooth boundary.

A2—8 to 30 inches; pink (7.5YR 7/4) fine sand, light brown (7.5YR 6/4) moist; weak fine granular structure; soft, very friable; medium acid; clear smooth boundary.

B2t—30 to 48 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate coarse prismatic structure; hard, friable; clay film on faces of peds; medium acid; diffuse smooth boundary.

B3—48 to 58 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 5/6) moist; weak coarse prismatic structure; slightly hard, friable; clay films on faces of peds; slightly acid; diffuse smooth boundary.

C—58 to 72 inches; reddish yellow (5YR 7/6) fine sandy loam, reddish yellow (5YR 6/6) moist; massive; slightly hard, very friable; medium acid.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. All horizons range from medium acid to neutral. Thickness of the A horizons ranges from 20 to 40 inches. The A1 horizon is brown, grayish brown, pink, pale brown, or light brown. The A2 horizon is pink, light brown, light yellowish brown, pale brown, or very pale brown. The B2t horizon is reddish brown, yellowish red, reddish yellow, or red fine sandy loam or sandy clay loam. The B3 and C horizons are red, reddish brown, yellowish red, or reddish yellow fine sandy loam or sandy clay loam.

Eufaula Series

The Eufaula series consists of deep, rapidly permeable, somewhat excessively drained, gently sloping to moderately steep soils on uplands. These soils formed in sandy sediment under a cover of oak forest and an understory of tall grasses.

Representative profile of Eufaula fine sand, 5 to 12 percent slopes, 600 feet west and 10 feet north of the southeast corner of sec. 36, T. 5 N., R. 8 W.

A1—0 to 6 inches; pinkish gray (7.5YR 6/2) fine sand, dark brown (7.5YR 4/2) moist; weak fine granular structure; loose; slightly acid; gradual diffuse boundary.

A21—6 to 30 inches; pink (5YR 7/4) fine sand, light reddish brown (5YR 6/4) moist; single grained; loose; slightly acid; clear wavy boundary.

A22&B2t—30 to 72 inches; pink (5YR 7/4) fine sand, light reddish brown (5YR 6/4) moist (A22); single grained; loose; lamellae of red (2.5YR 4/6) loamy fine sand (B2t); lamellae are massive, slightly hard, friable, wavy and discontinuous, 1/8 inch to 2 inches thick, and 1 to 4 inches apart; lamellae have clay bridges between the sand grains; medium acid.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A1 horizon is brown, light brown, pinkish gray, pink, grayish brown, brown, light brownish gray, pale brown, very pale brown, or light gray fine sand or loamy fine sand. The A2 horizon is pinkish gray, light brown, or pink fine sand or loamy fine sand. The A1 and A21 horizons are medium acid to neutral. The A22 and B2t horizons are slightly or medium acid. The B2t horizon is red, yellowish red, reddish yellow, strong brown, or light red. The lamellae in the B2t horizon are horizontal and discontinuous, 1/8 inch to 2 inches thick, and 1 to 4 inches apart. Total thickness of the lamellae is more than 6 inches.

Gracemont Series

The Gracemont series consists of deep, moderately rapidly permeable, somewhat poorly drained, nearly level soils on flood plains. These soils formed in loamy and sandy sediment under a cover of willow, cottonwood, saltcedar, and other water tolerant shrubs. They are subject to flooding.

Representative profile of Gracemont fine sandy loam, 1,850 feet south and 285 feet west of the northeast corner of sec. 9, T. 3 N., R. 8 W.

A1—0 to 10 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; slightly hard, very friable; neutral; gradual smooth boundary.

C—10 to 28 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, very friable; strata up to 1/2 inch thick of darker loam are separated from the mass by evident bedding planes; calcareous; moderately alkaline; clear smooth boundary.

Ab—28 to 46 inches; dark gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; massive; slightly hard, friable; common soft spots and threads of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

Cb—46 to 72 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; massive; slightly hard, friable; many threads and spots of calcium carbonate; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is 1/2 foot to 3 feet. The A horizon is dark brown, strong brown, brown, yellowish brown, or dark yellowish brown. It is neutral to moderately alkaline. Some pedons are noncalcareous in the upper 10 inches. The C horizon is reddish brown, yellowish red, light reddish brown, reddish yellow, dark brown, strong brown, brown, or light brown fine sandy loam or loam. The Ab horizon is dark brown, strong brown, dark gray, very dark gray, or very dark grayish brown fine sandy loam or loam. Depth to the Ab horizon ranges from 20 to 40 inches, but averages about 28 inches. In color and texture the Cb horizon is similar to the Ab horizon. The color is generally 1 or 2 units of value higher.

Gracemore Series

The Gracemore series consists of deep, moderately rapidly permeable, somewhat poorly drained, nearly level soils on flood plains. These soils formed in sandy sediment under a cover of willow, cottonwood, and saltcedar and an understory of tall grasses. They are subject to flooding.

Representative profile of Gracemore loamy fine sand in an area of Gracemore soils, 540 feet south and 450 feet east of the northwest corner of sec. 22, T. 10 N., R. 6 W.

- A1—0 to 10 inches; light brown (7.5YR 6/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable; calcareous; moderately alkaline; clear smooth boundary.
- C1—10 to 40 inches; pink (7.5YR 7/4) loamy fine sand, light brown (7.5YR 6/4) moist; single grained; loose; $\frac{1}{8}$ - to $\frac{1}{2}$ -inch strata of darker colored fine sandy loam; bedding planes are evident; water table at 30 inches; calcareous; moderately alkaline; gradual smooth boundary.
- C2—40 to 72 inches; pink (7.5YR 8/4) fine sand, pink (7.5YR 7/4) moist; single grained; loose; few thin strata of clay and clay loam; some clean sand; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the high water table is $\frac{1}{2}$ foot to 3 feet. The A horizon is grayish brown, dark brown, yellowish brown, light brown, or brown fine sand to clay loam. It is mildly or moderately alkaline. The C horizon is pink, light reddish brown, dark brown, yellowish brown, brown, light brown, grayish brown, or pale brown loamy fine sand or fine sand. It contains strata of clay loam and fine sandy loam that are generally less than 1 inch thick. It is mildly or moderately alkaline.

Grant Series

The Grant series consists of deep, moderately permeable, very gently sloping to strongly sloping, well drained soils on uplands. These soils formed in material weathered from sandstone or siltstone under a cover of tall prairie grasses.

Representative profile of Grant silt loam, 1 to 3 percent slopes, 1,030 feet south and 50 feet east of the northwest corner of sec. 34, T. 3 N., R. 8 W.

- A1—0 to 12 inches; brown (7.5YR 5/2) silt loam, dark brown (5YR 3/2) moist; moderate fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
- B1—12 to 16 inches; reddish brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.
- B21t—16 to 24 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure; hard, firm; clay films on faces of peds; neutral; gradual smooth boundary.
- B22t—24 to 45 inches; red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; weak medium and coarse subangular blocky structure; clay films on faces of peds; hard, firm; neutral; clear smooth boundary.
- B3—45 to 50 inches; red (2.5YR 5/8) silty clay loam, red (2.5YR 4/8) moist; weak coarse subangular blocky structure; hard, firm; mildly alkaline; gradual smooth boundary.
- C—50 to 72 inches; red and reddish brown soft siltstone that has thin seams of gypsum; calcareous in seams.

Depth to bedrock is 40 to more than 72 inches. Depth to the water table is more than 72 inches. Thickness of the solum is 40 to 60 inches. The A horizon is brown, dark brown, reddish gray, reddish brown, or dark reddish gray. It is slightly acid or neutral. The B1 horizon is similar to the A horizon in color and reaction. It is silt loam or silty clay loam. The B2t and B3 horizons are reddish brown, yellowish red, or red silt loam or silty clay loam. They are slightly acid to mildly alkaline. The C horizon is rippable, reddish, weakly consolidated siltstone or sandstone.

Hinkle Series

The Hinkle series consists of deep, very slowly per-

meable, very gently sloping, moderately well drained soils on uplands. These soils formed in material weathered from soft shale under a cover of tall and mid grasses.

The Hinkle soils in this county are mapped only with Renfrow soils.

Representative profile of Hinkle silt loam in an area of Renfrow-Hinkle complex, 1 to 3 percent slopes, 75 feet south and 2,715 feet west of the northeast corner of sec. 19, T. 8 N., R. 7 W.

- Ap—0 to 6 inches; reddish brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm; the upper $\frac{1}{2}$ inch is a vesicular crust; mildly alkaline; clear wavy boundary.
- B21t—6 to 14 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure breaking to fine subangular blocky; hard, friable; mildly alkaline; gradual smooth boundary.
- B22t—14 to 26 inches; red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; moderate medium prismatic structure; very hard, very firm; clay films on faces of peds; few small black concretions; common films and spots of salt; common threads and films of calcium carbonate; moderately alkaline; gradual smooth boundary.
- B3—26 to 42 inches; light red (2.5YR 6/8) silty clay loam; weak medium subangular blocky structure; slightly hard, firm; many films of calcium carbonate; moderately alkaline; clear smooth boundary.
- C—42 to 45 inches; red sandy shale.

Depth to bedrock is 40 to more than 60 inches. Depth to the water table is more than 72 inches. The A horizon is dark reddish gray, reddish brown, brown, or dark brown. It is slightly acid to moderately alkaline. In most areas a surface crust forms after rains. This crust dries to lighter colors than the Ap horizon. The B2t horizon is reddish brown, red, brown, dark brown, or light red clay loam, silty clay loam, or silty clay. It is neutral to moderately alkaline. Color in the B3 horizon is commonly 1 or 2 units of value higher than in the B2t horizon. The B3 horizon is silty clay loam, clay loam, or silty clay and is mildly or moderately alkaline. The C horizon is rippable, reddish sandy or clayey shale.

Keokuk Series

The Keokuk series consists of deep, moderately permeable, nearly level, well drained soils on flood plains. These soils formed in loamy sediment under a cover of oak, pecan, and cottonwood and an understory of tall grasses. They are subject to flooding.

Representative profile of Keokuk very fine sandy loam, 500 feet south and 600 feet east of the northwest corner of sec. 18, T. 10 N., R. 6 W.

- A1—0 to 13 inches; brown (7.5YR 5/2) very fine sandy loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable; moderately alkaline; gradual smooth boundary.
- B2—13 to 28 inches; light brown (7.5YR 6/4) very fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, friable; few dark and light colored strata; few films and threads of secondary carbonates; calcareous; moderately alkaline; gradual smooth boundary.
- C—28 to 60 inches; light reddish brown (5YR 6/4) very fine sandy loam, reddish brown (5YR 5/4) moist; massive; soft, very friable; few darker and lighter colored strata; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 72 inches. The A horizon is brown, dark grayish brown, or grayish brown. It is neutral to moderately alkaline. The B2 horizon is light reddish brown,

reddish brown, light brown, or brown and is neutral to moderately alkaline. It is mostly very fine sandy loam, but is silt loam in some pedons. Some pedons have coarser or finer textures below 50 inches. The C horizon is pale brown, light brown, or light reddish brown very fine sandy loam or loam. It is neutral to moderately alkaline.

Kirkland Series

The Kirkland series consists of deep, very slowly permeable, nearly level, well drained soils on uplands. These soils formed in material weathered from shale under a cover of tall and mid grasses.

Representative profile of Kirkland silt loam, 0 to 1 percent slopes, 1,590 feet south and 2,690 feet east of the northwest corner of sec. 16, T. 8 N., R. 7 W.

- Ap—0 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.
- B21t—10 to 18 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure, extremely hard, very firm; clay films on faces of peds; some vertical faces have silt loam coatings; roots more abundant on ped faces than inside peds; mildly alkaline; gradual smooth boundary.
- B22t—18 to 42 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; extremely hard, very firm; clay films on faces of peds; some vertical faces on blocks contain silt loam; few fine black concretions; few coarse calcium carbonate concretions starting at 24 inches; mildly alkaline; gradual smooth boundary.
- B23tca—42 to 56 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; few fine and medium distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; clay films on faces of peds, few peds with silt loam on vertical faces; few spots of gypsum; few calcium carbonate concretions; few spots of soft calcium carbonate; moderately alkaline; calcareous; gradual smooth boundary.
- B3—56 to 72 inches; brown (7.5YR 5/2) silty clay, dark brown (7.5YR 4/2) moist; common medium distinct yellowish red (5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; few gypsum crystals; few soft spots of calcium carbonate; moderately alkaline; calcareous; gradual smooth boundary.
- C—72 to 75 inches; red (2.5YR 5/6) soft clayey shale; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is dark brown, brown, very dark grayish brown, or dark grayish brown. It is slightly acid or neutral. The B2t horizon is dark brown, brown, very dark grayish brown, dark grayish brown, or reddish brown clay or silty clay. It is neutral or mildly alkaline. The B23tca and B3 horizons are reddish brown, yellowish red, brown, dark brown, or dark yellowish brown clay or silty clay. They are mildly or moderately alkaline.

Konawa Series

The Konawa series consists of deep, moderately permeable, nearly level to sloping, well drained soils on uplands. These soils formed in loamy and sandy sediment under a cover of oak forest and an understory of tall grasses.

Representative profile of Konawa loamy fine sand, 0 to 3 percent slopes, 150 feet west and 50 feet north of the southeast corner of sec. 27, T. 3 N., R. 7 W.

- Ap—0 to 5 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.
- A2—5 to 12 inches; pale brown (10YR 6/3) loamy fine sand, dark brown (10YR 4/3) moist; single grained; slightly hard, very friable; medium acid; clear smooth boundary.
- B21t—12 to 30 inches; reddish brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable; many pores; clay films on faces of peds; medium acid; diffuse smooth boundary.
- B22t—30 to 44 inches; yellowish red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) moist; weak coarse subangular blocky structure; slightly hard, friable; clay film on faces of peds; medium acid; diffuse smooth boundary.
- B3—44 to 56 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure; slightly hard, very friable; medium acid; diffuse smooth boundary.
- C—56 to 85 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; hard, friable; lamellae of red (2.5YR 4/6) fine sandy loam, $\frac{1}{4}$ to $\frac{1}{2}$ inch thick and 1 to 2 inches apart; neutral.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A1 horizon is brown, grayish brown, light brown, pale brown, or pink and is slightly or medium acid. The A2 horizon is brown, pinkish gray, light brown, grayish brown, light brownish gray, or pale brown and is slightly or medium acid. The B horizon is reddish yellow, reddish brown, yellowish red, or red sandy clay loam or fine sandy loam. It is slightly or medium acid. In color, the C horizon is similar to the B2t horizon. It is loamy fine sand or fine sandy loam and is medium acid to neutral.

Lela Series

The Lela series consists of deep, very slowly permeable, nearly level, somewhat poorly drained soils on flood plains. These soils formed in clayey sediment under a cover of tall grasses and scattered elm, pecan, and cottonwood. They are subject to flooding.

Representative profile of Lela silty clay, 20 feet east and 50 feet north of the southwest corner of sec. 27, T. 8 N., R. 8 W.

- Ap—0 to 7 inches; dark brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; moderate fine granular structure; hard, very firm; moderately alkaline; clear smooth boundary.
- A1—7 to 16 inches; dark brown (7.5YR 4/2) silty clay, dark brown (7.5YR 3/2) moist; strong medium subangular blocky structure; very hard, very firm; moderately alkaline; gradual wavy boundary.
- AC1—16 to 30 inches; dark reddish gray (5YR 4/2) silty clay, dark reddish brown (5YR 3/2) moist; moderate medium blocky structure; extremely hard, very firm; few intersecting slickensides in lower part; shiny pressure surfaces on faces of peds; dark brown soil material in some cracks; common fine soft spots of calcium carbonate, few fine calcium carbonate concretions; calcareous; moderately alkaline; gradual wavy boundary.
- AC2—30 to 60 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; moderate coarse blocky structure; very hard, very firm; few intersecting slickensides; common medium and coarse calcium carbonate concretions; calcareous; moderately alkaline; diffuse smooth boundary.
- C—60 to 75 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Thickness of the A and AC hori-

zons combined is 20 to more than 60 inches. Some pedons contain gypsum crystals below 40 inches. When dry, this soil has cracks ranging from $\frac{1}{4}$ inch to 1 inch wide at a depth of 20 inches. The A horizon is dark reddish brown, dark brown, or very dark brown and is neutral to moderately alkaline. The AC horizon is dark reddish gray, very dark brown, reddish brown, dark reddish brown, or dark brown clay or silty clay. It is mildly or moderately alkaline. The C horizon is similar to the AC horizon in color, texture, and reaction.

Lucien Series

The Lucien series consists of shallow, moderately rapidly permeable, very gently sloping to strongly sloping, well drained soils on uplands. These soils formed in material weathered from siltstone or sandstone under a cover of tall and mid grasses.

Representative profile of Lucien silt loam in an area of Lucien-Nash complex, 5 to 12 percent slopes, 685 feet west and 30 feet south of the northeast corner of sec. 6, T. 8 N., R. 5 W.

- A1—0 to 7 inches; reddish brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) moist; weak fine granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.
- B2—7 to 18 inches; red (2.5YR 5/6) silt loam, red (2.5YR 4/6) moist; moderate coarse granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.
- C—18 to 24 inches; red siltstone and sandstone.

Depth to bedrock is 10 to 20 inches. Depth to the water table is more than 72 inches. The horizons are slightly acid or neutral. The A horizon is brown or reddish brown. The B horizon is reddish brown, yellowish red, or red silt loam, loam, or very fine sandy loam. The C horizon is ripplable, reddish siltstone, shale, or sandstone.

McLain Series

The McLain series consists of deep, slowly permeable, nearly level, moderately well drained soils on flood plains. These soils formed in clayey or loamy sediment under a cover of tall grasses and scattered pecan, elm, and cottonwood. They are subject to flooding.

Representative profile of McLain silty clay loam, 1,980 feet east and 2,600 feet south of the northwest corner of sec. 24, T. 7 N., R. 8 W.

- A1—0 to 11 inches; dark brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure parting to fine subangular blocky and granular; hard, friable; neutral; gradual smooth boundary.
- B21t—11 to 28 inches; reddish brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) moist; strong fine blocky structure; very hard, firm; clay films on faces of peds; many roots; neutral; gradual smooth boundary.
- B22t—28 to 38 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; moderate fine blocky structure; very hard, firm; clay films on faces of peds; many roots; moderately alkaline; gradual smooth boundary.
- B3—38 to 50 inches; reddish brown (5YR 5/4) silty clay, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; very hard, very firm; few soft spots of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.
- C—50 to 60 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; massive; hard, firm; common soft spots of calcium carbonate; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Soft powdery secondary carbonates are at a depth of 36 to 48 inches. The A horizon is dark brown, brown, dark reddish brown, dark reddish gray, or reddish brown. It is slightly acid or neutral. The B2t horizon is dark reddish brown, reddish brown, or dusky red silty clay loam or silty clay. It ranges from neutral to moderately alkaline. In color, texture, and reaction, the B3 horizon is similar to the B2t horizon. The C horizon is silt loam, silty clay loam, or silty clay. It ranges from neutral to moderately alkaline.

Minco Series

The Minco series consists of deep, moderately permeable, nearly level to steep, well drained soils on uplands. These soils formed in loamy sediment under a cover of tall grasses.

Representative profile of Minco silt loam, 1 to 3 percent slopes, 1,035 feet south and 300 feet east of the northwest corner of sec. 26, T. 10 N., R. 6 W.

- Ap—0 to 7 inches; dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak medium granular structure; slightly hard, very friable; many fine roots; slightly acid; abrupt smooth boundary.
- A1—7 to 15 inches; dark brown (7.5YR 4/3) silt loam, dark brown (7.5YR 3/3) moist; moderate medium granular structure; slightly hard, very friable; many fine roots; slightly acid; gradual smooth boundary.
- B21—15 to 24 inches; reddish brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure; slightly hard, friable; common fine roots; moderately alkaline; gradual smooth boundary.
- B22—24 to 38 inches; light reddish brown (5YR 6/4) silt loam, reddish brown (5YR 5/4) moist; moderate medium prismatic structure; slightly hard, friable; common fine roots; moderately alkaline; gradual smooth boundary.
- B23—38 to 55 inches; red (2.5YR 5/6) silt loam, red (2.5YR 4/6) moist; weak coarse prismatic structure; slightly hard, friable; few fine roots; moderately alkaline; gradual smooth boundary.
- C—55 to 72 inches; red (2.5YR 5/8) silt loam, red (2.5YR 4/8) moist; massive; slightly hard, friable; few fine roots; few films of secondary carbonates; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is dark brown, dark grayish brown, brown, or grayish brown silt loam or very fine sandy loam. It is medium acid to neutral. The B2 horizon is red, reddish brown, yellowish red, brown, or light reddish brown loam, silt loam, or very fine sandy loam. It ranges from slightly acid to moderately alkaline. In color and reaction the C horizon is similar to the B2 horizon. In some pedons it is calcareous. It is a silt loam or very fine sandy loam.

Mapping unit 24 has a mollic epipedon that is a few inches thinner than defined in the range for the series, but this difference does not significantly affect the use and management of the soil.

Nash Series

The Nash series consists of moderately deep, moderately permeable, very gently sloping to strongly sloping, well drained soils on uplands. These soils formed in material weathered from sandstone under a cover of tall grasses.

Representative profile of Nash loam, 3 to 5 percent slopes, 44 feet north and 715 feet west of the southeast corner of sec. 13, T. 9 N., R. 8 W.

- A1—0 to 12 inches; reddish brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; moderate fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
- B2—12 to 30 inches; yellowish red (5YR 4/6) loam, yellowish red (5YR 3/6) moist; moderate medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.
- B3—30 to 34 inches; red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; weak coarse prismatic structure; soft, very friable; mildly alkaline; clear smooth boundary.
- C—34 to 40 inches; red (2.5YR 4/8) weakly consolidated sandstone; moderately alkaline.

Depth to bedrock is 20 to 40 inches. Depth to the water table is more than 72 inches. All horizons are slightly acid to moderately alkaline. The A horizon is dark brown, brown, or reddish brown. The B2 horizon is reddish brown, yellowish red, or red silt loam, loam, or very fine sandy loam. The B3 horizon is yellowish red or red silt loam to very fine sandy loam. The C horizon is ripplable, reddish sandstone.

Noble Series

The Noble series consists of deep, moderately rapidly permeable, very gently sloping to moderately steep, well drained soils on uplands. These soils formed in loamy sediment under a cover of oak forest and an understory of tall grasses.

Representative profile of Noble fine sandy loam, 1 to 3 percent slopes, 50 feet east and 450 feet south of the northwest corner of sec. 17, T. 6 N., R. 8 W.

- Ap—0 to 7 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.
- A1—7 to 18 inches; reddish brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; moderate medium granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.
- B2—18 to 44 inches; red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) moist; weak coarse subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.
- C—44 to 65 inches; light red (2.5YR 6/6) fine sandy loam, red (2.5YR 5/6) moist; massive; slightly hard, very friable; neutral.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is reddish brown, dark brown, or brown. It is medium acid to neutral. The B2 horizon is reddish brown, yellowish red, or red fine sandy loam or loam. It is slightly acid or neutral. The C horizon is reddish brown, red, or light red fine sandy loam or loam. It is slightly acid or neutral.

Norge Series

The Norge series consists of deep, moderately slowly permeable, nearly level to gently sloping, well drained soils on uplands. These soils formed in loamy sediment under a cover of tall prairie grasses.

Representative profile of Norge silt loam, 0 to 1 percent slopes, 2,460 feet west and 50 feet north of the southeast corner of sec. 5, T. 7 N., R. 7 W.

- A1—0 to 11 inches; dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, friable; slightly acid; gradual smooth boundary.
- B1—11 to 16 inches; reddish brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; slightly hard, friable;

many fine pores; slightly acid; gradual smooth boundary.

- B21t—16 to 34 inches; reddish brown (5YR 5/4) silty clay loam, dark reddish brown (5YR 3/4) moist; strong medium and fine subangular blocky structure; hard, firm; nearly continuous clay films on faces of pedis; slightly acid; gradual smooth boundary.
- B22t—34 to 58 inches; yellowish red (5YR 4/6) silty clay loam, yellowish red (5YR 3/6) moist; moderate medium subangular blocky structure; hard, firm; nearly continuous clay films on faces of pedis; slightly acid; gradual smooth boundary.
- B3—58 to 64 inches; yellowish red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; weak coarse subangular blocky structure; slightly hard, friable; patchy clay films on faces of pedis; few iron concretions; few calcium carbonate concretions; mildly alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is reddish brown, dark brown, brown, dark grayish brown, or grayish brown. It ranges from medium acid to neutral. The B1 horizon is grayish brown, dark grayish brown, or reddish brown silt loam or silty clay loam. It ranges from medium acid to neutral. The B2t horizon is reddish brown, yellowish red, or red silty clay loam or clay loam. It ranges from acid to mildly alkaline. The B3 horizon is similar to the B2t horizon in color and texture. It ranges from slightly acid to moderately alkaline.

Pocasset Series

The Pocasset series consists of deep, moderately permeable, nearly level, well drained soils on flood plains. These soils formed in calcareous, loamy sediment under a cover of tall grasses and scattered pecan, elm, and cottonwood. They are subject to flooding.

Representative profile of Pocasset silty clay loam, 2,630 feet south and 2,630 feet west of the northeast corner of sec. 5, T. 6 N., R. 6 W.

- Ap—0 to 14 inches; reddish brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate fine granular structure; hard, firm; many fine roots; calcareous; moderately alkaline; clear smooth boundary.
- C—14 to 72 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 5/6) moist; massive; slightly hard, very friable; many fine roots; very thin to 1-inch strata of darker colored silt loam and loam and light colored loamy fine sand; bedding planes are evident; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. All horizons are moderately alkaline and calcareous. Some pedons are leached of lime and are neutral to moderately alkaline in the upper 10 inches. The A horizon is reddish gray; dark reddish gray, or reddish brown. The C horizon is reddish yellow, yellowish red, light reddish brown, or red fine sandy loam, very fine sandy loam, or loam. It contains thin strata of coarser or finer material.

Pond Creek Series

The Pond Creek series consists of deep, moderately slowly permeable, nearly level or very gently sloping, well drained soils on uplands. These soils formed in loamy sediment under a cover of tall prairie grasses.

Representative profile of Pond Creek silt loam, 0 to 1 percent slopes, 500 feet north and 60 feet east of the southwest corner of sec. 18, T. 10 N., R. 7 W.

- A1—0 to 12 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; moderate fine granular

structure; soft, very friable; slightly acid; gradual smooth boundary.

- B1—12 to 20 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; strong medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.
- B2t—20 to 32 inches; brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; hard, friable; clay films on faces of peds; slightly acid; gradual smooth boundary.
- B22t—32 to 45 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist; common fine distinct mottles of brownish yellow; moderate medium subangular blocky structure; slightly hard, firm; clay films on faces of peds; few iron concretions; slightly acid; gradual smooth boundary.
- B3—45 to 60 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, friable; few spots of calcium carbonate; moderately alkaline; gradual smooth boundary.
- C—60 to 72 inches; brown (7.5YR 5/4) silty clay loam; massive; hard, friable; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is dark brown, brown, grayish brown, or dark grayish brown. It is medium acid to neutral. In color, the B1 horizon is similar to the A horizon. It is silt loam or silty clay loam. It is slightly acid or neutral. The B2t horizon is dark brown, brown, dark grayish brown, dark yellowish brown, yellowish brown, or reddish brown silt loam or silty clay loam. It is slightly acid or neutral. The B3 horizon is reddish brown, dark brown, brown, yellowish brown, or dark yellowish brown silty clay loam or clay loam. It is neutral to moderately alkaline. The C horizon is brown, reddish brown, yellowish red, dark brown, or strong brown. It ranges from neutral to moderately alkaline.

Port Series

The Port series consists of deep, moderately permeable, nearly level, well drained soils on flood plains. These soils formed in loamy sediment under a cover of tall grasses and scattered elm, pecan, and cottonwood. They are subject to flooding.

Representative profile of Port silt loam, 300 feet south and 100 feet east of the northwest corner of sec. 24, T. 7 N., R. 6 W.

- Ap—0 to 9 inches; reddish brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; soft, very friable; neutral; clear smooth boundary.
- A1—9 to 27 inches; dark reddish brown (5YR 3/3) silt loam, dark reddish brown (5YR 2/2) moist; moderate coarse granular structure; slightly hard, friable; few fine pores; neutral; gradual smooth boundary.
- B2—27 to 42 inches; reddish brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; weak coarse granular structure; hard, firm; thin strata of darker soil; common spots and films of calcium carbonate; calcareous; moderately alkaline; diffuse smooth boundary.
- C—42 to 72 inches; reddish brown (2.5YR 5/4) silt loam, reddish brown (2.5YR 4/4) moist; massive; hard, firm; few thin strata of dark reddish brown silty clay loam; common spots and films of calcium carbonate; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Thickness of the Ap and A1 horizons combined is more than 20 inches. The A horizon is dark reddish brown, dark reddish gray, reddish gray, reddish brown, brown, or dark brown silt loam or fine sandy loam. It is slightly acid to mildly alkaline. The B2 horizon is dusky red, light red, dark reddish brown, dark brown, brown, or reddish brown silt loam or silty clay

loam. It ranges from neutral to moderately alkaline. The C horizon is dark reddish brown, reddish brown, brown, or dark brown silt loam or silty clay loam. It is mildly alkaline or moderately alkaline. Some pedons are stratified with both coarser and finer material below 40 inches.

Pulaski Series

The Pulaski series consists of deep, moderately rapidly permeable, nearly level, well drained soils on flood plains. These soils formed in loamy sediment under a cover of tall grasses and an overstory of pecan, elm, and cottonwood. They are subject to flooding.

Representative profile of Pulaski fine sandy loam, 1,400 feet east and 700 feet south of the northwest corner of sec. 21, T. 4 N., R. 5 W.

- Ap—0 to 10 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak fine granular structure; soft, very friable; slightly acid; gradual smooth boundary.
- C—10 to 60 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; soft, very friable; thin strata of reddish brown (5YR 4/4) fine sandy loam; slightly acid.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Reaction ranges from medium acid to neutral above 40 inches, but some pedons become alkaline below that depth. The A horizon is brown, strong brown, light brown, reddish yellow, reddish brown, or yellowish red. The C horizon is light brown, reddish yellow, light reddish brown, or yellowish red fine sandy loam or loam. It is stratified with finer and coarser material. The C horizon in some pedons is coarser or finer than fine sandy loam or loam below 40 inches.

Quinlan Series

The Quinlan series consists of shallow, moderately steep or steep, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone under a cover of tall and mid grasses.

Representative profile of Quinlan loam in an area of Quinlan-Rock outcrop complex, 12 to 30 percent slopes, 350 feet east and 50 feet north of the southwest corner of sec. 33, T. 9 N., R. 8 W.

- A—0 to 8 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak medium granular structure; soft, very friable; calcareous; moderately alkaline; gradual wavy boundary.
- B2—8 to 14 inches; red (2.5YR 5/8) loam, red (2.5YR 4/8) moist; weak medium granular structure; soft, very friable; few fragments of sandstone less than 3 inches in diameter; few films of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.
- C—14 to 30 inches; red (2.5YR 5/6) soft calcareous sandstone, red (2.5YR 4/6) moist.

Depth to bedrock is 10 to 20 inches. Depth to the water table is more than 72 inches. Typically the solum is calcareous throughout, but some pedons are noncalcareous and alkaline. The A horizon is brown, yellowish red, red, reddish brown, light reddish brown, or strong brown. It is mildly or moderately alkaline. The B horizon is red, yellowish red, strong brown, light reddish brown, or reddish brown loam or silt loam. It is mildly or moderately alkaline. The C horizon is ripplable, soft red sandstone. Some pedons have seams of gypsum.

Reinach Series

The Reinach series consists of deep, moderately permeable, nearly level, well drained soils on flood plains.

These soils formed in loamy sediment under a cover of tall prairie grasses and scattered pecan and elm. They are subject to flooding.

Representative profile of Reinach silt loam, 2,060 feet west and 65 feet north of the southeast corner of sec. 6, T. 7 N., R. 8 W.

Ap—0 to 9 inches; brown (7.5YR 5/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine and medium granular structure; slightly hard, very friable; neutral; clear smooth boundary.

A11—9 to 14 inches; reddish brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) moist; weak fine and medium granular structure; slightly hard, very friable; neutral; gradual smooth boundary.

A12—14 to 30 inches; reddish brown (2.5YR 5/3) silt loam, dark reddish brown (2.5YR 3/3) moist; weak fine and medium granular structure; slightly hard, very friable; few areas filled with darker material; many roots; many pores; many earthworm casts; mildly alkaline; gradual smooth boundary.

B2—30 to 50 inches; red (2.5YR 5/6) silt loam, red (2.5YR 4/6) moist; weak fine and medium granular structure; slightly hard, very friable; few areas filled with darker material; few spots and threads of calcium carbonate starting at 35 inches; many roots; many pores; many earthworm casts; calcareous; moderately alkaline; gradual smooth boundary.

C—50 to 84 inches; red (2.5YR 5/6) very fine sandy loam, red (2.5YR 4/6) moist; massive; slightly hard, very friable; few spots and films of calcium carbonate, a few calcium carbonate concretions; few worm casts; many roots; many pores; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. Soft, powdery calcium carbonate is between 20 and 60 inches. The A horizon is dark brown, brown, or reddish brown. It is slightly acid to moderately alkaline. The B2 horizon is red, weak red, reddish brown, yellowish red, or strong brown and is neutral to moderately alkaline. Color in the C horizon is commonly 1 or 2 units of value higher than in the B horizon. A few pedons have coarser and finer textures below 40 inches.

Renfrow Series

The Renfrow series consists of deep, very slowly permeable, very gently sloping to gently sloping, well drained soils on uplands. These soils formed in material weathered from clay beds or weakly consolidated clayey shale under a cover of tall and mid grasses.

Representative profile of Renfrow silt loam, 1 to 3 percent slopes, 300 feet north and 50 feet east of the southwest corner of sec. 14, T. 6 N., R. 7 W.

A1—0 to 9 inches; dark brown (7.5YR 4/3) silt loam, dark brown (7.5YR 3/3) moist; strong medium granular structure; slightly hard, friable; neutral; clear smooth boundary.

B1—9 to 15 inches; reddish brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; strong fine subangular blocky structure; hard, firm; neutral; clear smooth boundary.

B21t—15 to 26 inches; reddish brown (5YR 5/4) silty clay, reddish brown (5YR 4/4) moist; strong fine blocky structure; very hard, very firm; cracks filled with dark material similar to B1 horizon; few black concretions; clay films on faces of peds; neutral; diffuse smooth boundary.

B22t—26 to 45 inches; red (2.5YR 4/6) silty clay, dark red (2.5YR 3/6) moist; moderate medium and fine blocky structure; very hard, very firm; clay films on faces of peds; few soft spots of calcium carbonate; few black concretions; few vertical darker streaks of silt loam in cracks; few slick-

ensides that do not intersect; moderately alkaline; diffuse smooth boundary.

B3—45 to 65 inches; red (2.5YR 5/8) silty clay, red (2.5YR 4/8) moist; weak medium and fine blocky structure; very hard, very firm; few fragments of shale less than 1/2 inch in diameter; few soft spots of calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

C—65 to 70 inches; red (2.5YR 5/8) clayey shale, red (2.5YR 4/8) moist; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A1 horizon is dark brown, brown, reddish brown, or reddish gray. It is slightly acid or neutral. The B1 horizon is reddish gray, reddish brown, dark brown, or brown and ranges from slightly acid to mildly alkaline. The B2t horizon is yellowish red, reddish brown, or red clay or silty clay. It ranges from slightly acid to moderately alkaline. The B3 horizon is red or yellowish red clay or silty clay. It ranges from neutral to moderately alkaline. The C horizon is reddish clay or rip-pable clayey shale.

Rock Outcrop

The Rock outcrop in this county is mapped only with Quinlan soils. It is exposed sandstone bedrock.

Stephenville Series

The Stephenville series consists of moderately deep, moderately permeable, very gently sloping to moderately steep, well drained soils on uplands. These soils formed in material weathered from sandstone under a cover of oak forest and an understory of tall grasses.

Representative profile of Stephenville fine sandy loam, 3 to 5 percent slopes, 1,320 feet west and 180 feet south of the northeast corner of sec. 22, T. 6 N., R. 5 W.

A1—0 to 6 inches; brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 4/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

A2—6 to 10 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.

B2t—10 to 30 inches; reddish brown (2.5YR 5/4) sandy clay loam, reddish brown (2.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm; nearly continuous clay films on faces of peds; medium acid; gradual smooth boundary.

B3—30 to 38 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; weak coarse subangular blocky structure; slightly hard, friable; few patchy clay films on faces of peds; medium acid; gradual smooth boundary.

C—38 to 45 inches; red (2.5YR 4/8) soft sandstone.

Depth to bedrock is 20 to 40 inches. Depth to the water table is more than 72 inches. The A1 horizon is brown, pale brown, or grayish brown fine sandy loam or loamy fine sand. It is slightly or medium acid. The A2 horizon is light brown, pale brown, light brownish gray, or light reddish brown fine sandy loam or loamy fine sand. It is slightly acid or medium acid. The B2t horizon is reddish brown, yellowish red, or red sandy clay loam or fine sandy loam. It is medium acid or strongly acid. The B3 horizon is similar to the B2t horizon in color, texture, and reaction, but is commonly lower in clay content. The C horizon is rip-pable, reddish sandstone.

Teller Series

The Teller series consists of deep, moderately permeable, very gently sloping to sloping, well drained

soils on uplands. These soils formed in loamy sediment under a cover of tall grasses.

Representative profile of Teller loam, 1 to 3 percent slopes, 450 feet west and 100 feet north of the southeast corner of sec. 32, T. 10 N., R. 6 W.

Ap—0 to 9 inches; brown (7.5YR 5/3) loam, dark brown (7.5YR 3/3) moist; weak fine granular structure; soft, very friable; slightly acid; gradual smooth boundary.

A1—9 to 16 inches; dark brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; moderate to strong fine granular structure; slightly hard, very friable; slightly acid; gradual smooth boundary.

B21t—16 to 32 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable; clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—32 to 46 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; hard, firm; clay films on faces of peds; slightly acid; gradual smooth boundary.

B3—46 to 62 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure; slightly hard, friable; neutral; gradual smooth boundary.

C—62 to 72 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard, friable; neutral.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is brown, reddish brown, or dark brown and is slightly acid or medium acid. The B2t horizon is brown, reddish brown, yellowish red, or red sandy clay loam or clay loam. It is slightly or medium acid. In color, the B3 horizon is similar to the B2t horizon. It is loam or fine sandy loam and is medium acid to neutral. The C horizon is reddish brown or yellowish red alluvial sediment. It ranges from medium acid to neutral.

Mapping units 57 and 58 have a thinner mollic epipedon than defined in the range for the series, but this difference does not significantly affect the use and management of the soils.

Tivoli Series

The Tivoli series consists of deep, rapidly permeable, sloping or strongly sloping, excessively drained soils on uplands. These soils formed in sandy sediment under a cover of tall and mid grasses and scattered shrubs.

Representative profile of Tivoli loamy fine sand, 2,560 feet east and 2,220 feet south of the northwest corner of sec. 15, T. 10 N., R. 7 W.

A1—0 to 10 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine granular structure; loose; neutral; gradual smooth boundary.

C1—10 to 40 inches; light brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; single grained; loose; mildly alkaline; gradual smooth boundary.

C2—40 to 60 inches; pink (7.5YR 7/4) fine sand, light brown (7.5YR 6/4) moist; single grained; loose; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. The A horizon is brown, light brown, light reddish brown, grayish brown, or pale brown and is neutral or mildly alkaline. The C horizon is reddish brown, reddish yellow, brown, pink, or light brown and is neutral to moderately alkaline.

Windthorst Series

The Windthorst series consists of deep, moderately

slowly permeable, very gently sloping or gently sloping, moderately well drained soils on uplands. These soils formed in material weathered from shale and sandstone under a cover of oak forest and an understory of tall grasses.

Representative profile of Windthorst fine sandy loam, 1 to 3 percent slopes, 1,650 feet west and 120 feet south of the northeast corner of sec. 28, T. 6 N., R. 5 W.

A1—0 to 4 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

A2—4 to 10 inches; light brown (7.5YR 6/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable; medium acid; abrupt wavy boundary.

B21t—10 to 19 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate to strong medium blocky structure; very hard, very firm; nearly continuous clay films on faces of peds; few fine black concretions; medium acid; gradual smooth boundary.

B22t—19 to 36 inches; reddish yellow (5YR 6/6) clay, yellowish red (5YR 4/6) moist; moderate medium and coarse blocky structure; very hard, very firm; clay films on faces of peds; few fine black concretions; medium acid; gradual smooth boundary.

B23t—36 to 46 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; weak medium subangular blocky structure; hard, firm; clay films on faces of peds; slightly acid; gradual smooth boundary.

B3—46 to 52 inches; coarsely mottled red (2.5YR 5/6), yellowish red (5YR 5/6), and reddish yellow (5YR 6/6) clay loam; weak medium subangular blocky structure; hard, firm; few dark concretions; few fragments of sandstone less than 3 inches in diameter; few soft spots of calcium carbonate; moderately alkaline; gradual smooth boundary.

C—52 to 60 inches; stratified reddish sandstone and sandy shale; moderately alkaline.

Depth to bedrock is 40 to more than 60 inches. Depth to the water table is more than 72 inches. The A1 horizon is brown, pale brown, grayish brown, or light brownish gray. The A1 and A2 horizons are medium acid to neutral. Color in the A2 horizon is 1 or 2 units of value higher than in the A1 horizon. The B2t horizon is red, reddish brown, yellowish red, or reddish yellow clay, sandy clay, or clay loam. It is slightly or medium acid. The B3 horizon is similar to the B2t horizon in color and texture. It is medium acid to moderately alkaline. The C horizon is stratified, rippable, reddish sandstone and sandy shale.

Yahola Series

The Yahola series consists of deep, moderately rapidly permeable, nearly level, well drained soils on flood plains. These soils formed in loamy sediment under a cover of elm, pecan, and cottonwood and an understory of tall grasses. They are subject to flooding.

Representative profile of Yahola fine sandy loam, 225 feet west and 100 feet north of the southeast corner of sec. 33, T. 8 N., R. 8 W.

Ap—0 to 10 inches; reddish brown (5YR 5/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; moderate medium granular structure; slightly hard, friable; calcareous; moderately alkaline; gradual smooth boundary.

C1—10 to 25 inches; reddish brown (5YR 5/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; massive; soft, very friable; calcareous; moderately alkaline; gradual smooth boundary.

C2—25 to 60 inches; light reddish brown (5YR 6/4) fine

sandy loam, reddish brown (5YR 4/4) moist; massive; soft, very friable; thin strata of loamy fine sand to loam; calcareous; moderately alkaline.

Depth to bedrock is more than 5 feet. Depth to the water table is more than 6 feet. All horizons are moderately alkaline and calcareous. The A horizon is brown, light brown, strong brown, or reddish brown. The C horizon is reddish brown, light red, reddish yellow, yellowish red, brown, or light reddish brown. It is mainly fine sandy loam, but is stratified with finer and coarser material.

Zaneis Series

The Zaneis series consists of deep, moderately slowly permeable, very gently sloping to sloping, well drained soils on uplands. These soils formed in material weathered from sandstone and sandy shale under a cover of tall grasses.

Representative profile of Zaneis loam, 1 to 3 percent slopes, 900 feet south and 50 feet east of the northwest corner of sec. 34, T. 8 N., R. 5 W.

- A1—0 to 13 inches; dark brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; moderate fine granular structure; slightly hard, friable; neutral; gradual smooth boundary.
- B1—13 to 18 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate medium and fine subangular blocky structure; hard, firm; clay films on faces of peds; neutral; gradual smooth boundary.
- B2t—18 to 44 inches; red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; moderate medium blocky structure; very hard, very firm; few iron concretions; clay films on faces of peds; neutral; gradual smooth boundary.
- B3—44 to 50 inches; red (2.5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) moist; weak coarse subangular blocky structure; hard, firm; common fine and medium black concretions; few sandstone fragments; slightly acid; gradual smooth boundary.
- C—50 to 58 inches; dark red (2.5YR 3/6) and light gray (10YR 6/1) alternating layers of sandstone and sandy shale.

Depth to bedrock ranges from 40 to 60 inches. Depth to the water table is more than 72 inches. The A horizon is dark brown, brown, reddish brown, or dark reddish gray. It ranges from medium acid to neutral. The B1 horizon is brown, dark brown, or reddish brown clay loam or sandy clay loam. It ranges from medium acid to neutral. The B2t horizon is red, reddish brown, or yellowish red clay loam or sandy clay loam. It is slightly acid or neutral. The B3 horizon is similar to the B2t horizon in color and texture. It is slightly acid to mildly alkaline. The C horizon is rippable, reddish sandstone or shale.

Formation and Classification of Soils

This section describes the factors of soil formation, relates them to the formation of soils in the county, and explains the processes of soil formation. It also defines the current system of classifying soils and classifies the soils of the county according to that system.

Soil is a natural, three dimensional body on the earth's surface that supports plants and has properties resulting from the integrated effect of the climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

The interaction of five main factors results in differences among the soils. These factors are the physi-

cal and chemical composition of the parent material; the climate during and after the accumulation of the parent material; the kind of plants and organisms living in the soil; the relief of the land and its effect on runoff; and the length of time it took the soil to form.

The effect of one factor can differ from place to place, but the interaction of all the factors determines the kind of soil that forms. In the following paragraphs the factors of soil formation are described as they relate to the soils in the survey area.

Factors of Soil Formation

Soil is the product of the interaction of the five major factors of soil formation—climate, parent material, plants and animals (especially plants), relief, and time.

Climate.—Grady County has a dry, subhumid, continental climate. Summers are hot and generally dry. Winters are generally mild, but severe cold spells sometimes occur. Rainfall is heaviest in spring and is commonly so intense that erosion is severe on many soils. Differences in the soils of the county cannot be attributed to climate because the climate throughout the county is nearly uniform.

Parent material.—Parent material, the unconsolidated mass from which soils form, has a direct influence on the physical, chemical, and mineralogical composition of the soils. The soils in Grady County formed mainly in material weathered from sandstone and shale and in loamy, clayey, or sandy sediment.

Soils formed in material weathered from sandstone are Darnell, Grant, Lucien, Nash, Quinlan, Stephenville, and Zaneis. Alternating strata of material weathered from sandstone, shale, and siltstone occur in some of these upland soils. Soils formed in material weathered from shale are Bethany, Hinkle, Kirkland, Renfrow, and Windthorst. Soils formed in loamy, clayey, or sandy sediment on uplands are Bethany, Dougherty, Eufaula, Hinkle, Kirkland, Konawa, Minco, Noble, Norge, Pond Creek, Renfrow, Teller, and Tivoli. Soils formed in loamy, clayey, or sandy sediment on flood plains are Amber, Cyril, Dale, Gracemont, Grace-more, Keokuk, Lela, McLain, Pocasset, Port, Pulaski, Reinach, and Yahola.

Plants and animals.—Plants, burrowing animals, insects, and micro-organisms have a direct influence on the formation of soils. The native grasses and trees in the county have had different effects on the losses and gains of organic matter and plant nutrients and on soil structure and porosity. Pond Creek, Minco, Norge, and Grant soils formed under native grasses. The fibrous roots of these native grasses promote good granular structure and add organic matter to the soil. Large amounts of plant nutrients are retained in the soils because the roots take in nutrients from deep in the soil and return a large part of them to the soil when the grasses die. Consequently, the soils in Grady County formed under native grass are less acid than the soils that formed under trees. Dougherty soils, which formed under scrub oaks, are more acid and lower in content of organic matter than the soils that formed under grass.

During the past 60 years, man has altered the na-

tural soil forming processes in much of the county. In clearing the land and cultivating the soils, man has caused severe loss of soil through sheet and gully erosion.

Relief.—Relief affects the formation of soils through its influence on moisture, drainage, erosion, soil temperature, and plant cover. In Grady County relief is determined largely by the resistance of underlying formations to weathering and geological erosion. About 20 percent of Grady County consists of nearly level soils on flood plains, and about 80 percent consists of nearly level to steep soils on uplands.

The general relief of the county is fairly uniform, but geological erosion has dissected broad plains and cut drainageways. Because of this cutting, differences in elevation are distinct. The steeper part of the county includes the scrub oak forests and sandstone hills.

Relief has had some influence on the formation of different profile characteristics in Kirkland and Renfrow soils; both formed in clayey material. Because Kirkland soils are nearly level, less water runs off the surface and more water percolates through the profile than in the more sloping Renfrow soils. This percolation influences the loss, gain, or transfer of soil constituents and influences other soil forming processes. Renfrow soils are in the same general area as Kirkland soils, but are redder.

Stephenville and Darnell soils formed from similar sandstone parent material on uplands; their development has been controlled largely by relief. Stephenville soils are generally less sloping than Darnell soils. Much of the rainfall runs off Darnell soils. Water moving through the profile promotes development of a deeper solum.

The relief of the soils on flood plains is closely related to soil drainage. The level to slightly depressional Gracemont soils are somewhat poorly drained, but the nearly level Yahola and Pulaski soils are well drained.

Time.—As a factor in soil formation, time cannot be measured strictly in years. The length of time needed for a soil to develop genetic horizons depends on the intensity and interreaction of the soil forming factors in promoting losses, gains, transfers, or transformations of soil constituents that are necessary for forming soil horizons. Soils that have no definite genetic horizons are young or immature. Mature soils are older soils that have approached equilibrium with their environment and have well defined horizons.

The soils of Grady County range from young to old. Some of the old soils are Kirkland and Bethany on uplands. Pond Creek, Norge, and Grant soils are younger, but they have well expressed horizons. Lucien and Darnell soils are considered young. They have had sufficient time to develop well expressed horizons, but because they are sloping, geological erosion has removed soil material as fast, or almost as fast, as it has formed. Yahola, Port, and Pulaski soils on flood plains have been developing for such a short time that they show little horizon development.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in

1965. Readers interested in further details about the system should refer to the latest literature available.⁵

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the bases for classification are the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 15 the soils of the survey area are classified according to the system. Classes of the system are briefly discussed in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and that are important to plant growth or that were selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. The name of a great group ends with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Haplaquents (*Hapl*, meaning simple horizons, plus *aquent*, the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group is divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades that have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. The names of subgroups are derived by placing one or more adjectives before the name of the great group. The adjective *Typic* is used for the subgroup that is thought to typify the great group. An example is Typic Ustifluvents.

FAMILY. Soil families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil

⁵ See the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy," available in the SCS State Office, Stillwater, Oklahoma.

TABLE 15.—*Classification of the soils*

Soil name	Family or higher taxonomic class
Amber -----	Coarse-silty, mixed, thermic Udic Ustochrepts
Bethany -----	Fine, mixed, thermic Pachic Paleustolls
Cyril -----	Coarse-loamy, mixed, thermic Cumulic Haplustolls
Dale -----	Fine-silty, mixed, thermic Pachic Haplustolls
Darnell -----	Loamy, siliceous, thermic, shallow Udic Ustochrepts
Dougherty ---	Loamy, mixed, thermic Arenic Haplustalfs
Eufaula -----	Sandy, siliceous, thermic Psammentic Paleustalfs
Gracemont ---	Coarse-loamy, mixed (calcareous), thermic Aquic Udifluvents
Gracemore ---	Sandy, mixed, thermic Aquic Udifluvents
Grant -----	Fine-silty, mixed, thermic Udic Argiustolls
Hinkle -----	Fine, montmorillonitic, thermic Mollic Natrustalfs
Keokuk -----	Coarse-silty, mixed, thermic Fluventic Haplustolls
Kirkland -----	Fine, mixed, thermic Udertic Paleustolls
Konawa -----	Fine-loamy, mixed, thermic Ultic Haplustalfs
Lela -----	Fine, mixed, thermic Typic Chromuderts
Lucien -----	Loamy, mixed, thermic, shallow Typic Haplustolls
McLain -----	Fine, mixed, thermic Pachic Argiustolls
Minco ¹ -----	Coarse-silty, mixed, thermic Udic Haplustolls
Nash -----	Coarse-silty, mixed, thermic Udic Haplustolls
Noble -----	Coarse-loamy, siliceous, thermic Udic Ustochrepts
Norge -----	Fine-silty, mixed, thermic Udic Paleustolls
Pocasset -----	Coarse-loamy, mixed, thermic Fluventic Haplustolls
Pond Creek ---	Fine-silty, mixed, thermic Pachic Argiustolls
Port -----	Fine-silty, mixed, thermic Cumulic Haplustolls
Pulaski -----	Coarse-loamy, mixed, nonacid, thermic Typic Ustifluvents
Quinlan -----	Loamy, mixed, thermic, shallow Typic Ustochrepts
Reinach -----	Coarse-silty, mixed, thermic Pachic Haplustolls
Renfrow -----	Fine, mixed, thermic Udertic Paleustolls
Stephenville --	Fine-loamy, siliceous, thermic Ultic Haplustalfs
Teller ² -----	Fine-loamy, mixed, thermic Udic Argiustolls
Tivoli -----	Mixed, thermic Typic Ustipsamments
Windthorst ---	Fine, mixed, thermic Udic Paleustalfs
Yahola -----	Coarse-loamy, mixed (calcareous), thermic Typic Ustifluvents
Zaneis -----	Fine-loamy, mixed, thermic Udic Argiustolls

¹ Soils of Unit 24 are taxajuncts to the Minco series. The mollic epipedon is too thin and is outside the range defined for the series. Otherwise, the soils are similar in morphology, use, behavior, and management.

² Soils of Units 57 and 58 are taxadjuncts to the Teller series. The mollic epipedon is too thin and is outside the range defined for the series. Otherwise, the soils are similar in morphology, use, behavior, and management.

properties used as family differentiae. An example is fine-loamy, mixed, thermic, Udic Argiustolls.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and have horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement of the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Literature Cited

- (1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway

materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

- (2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. In 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.
- (3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

Glossary

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low -----	0 to 3
Low -----	3 to 6
Moderate -----	6 to 9
High -----	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Color, soil. See Munsell notation.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

- Soft.**—When dry, breaks into powder or individual grains under very slight pressure.
- Cemented.**—Hard; little affected by moistening.
- Decreasers.** The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.
- Deferred grazing.** A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.
- Diversion (or diversion terrace).** A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.
- Drainage class (natural).** Refers to the frequency and duration of periods of saturation or partial saturation during soil formation as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. In Grady County five classes of natural soil drainage are recognized:
- Excessively drained.**—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
- Somewhat excessively drained.**—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
- Well drained.**—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
- Moderately well drained.**—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
- Somewhat poorly drained.**—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
- Erosion.** The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.
- Erosion (geologic).** Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
- Erosion (accelerated).** Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.
- Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.
- Flood plain.** A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.
- Genesis, soil.** The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.
- Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:
- A horizon.**—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.
- A₂ horizon.**—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.
- B horizon.**—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.
- C horizon.**—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.
- R layer.**—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.
- Humus.** The well decomposed, more or less stable part of the organic matter in mineral soils.
- Increasers.** Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.
- Invaders.** On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.
- Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.
- Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.
- Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).
- Munsell notation.** A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.
- Ped.** An individual natural soil aggregate, such as a granule, a prism, or a block.
- Permeability.** The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).
- Phase, soil.** A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.
- pH value.** (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.
- Plasticity index.** The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—excellent, good, fair, and poor. The classification is based on the percentage of original or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		pH
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 30 percent or more silt and less than 12 percent clay.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable

sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

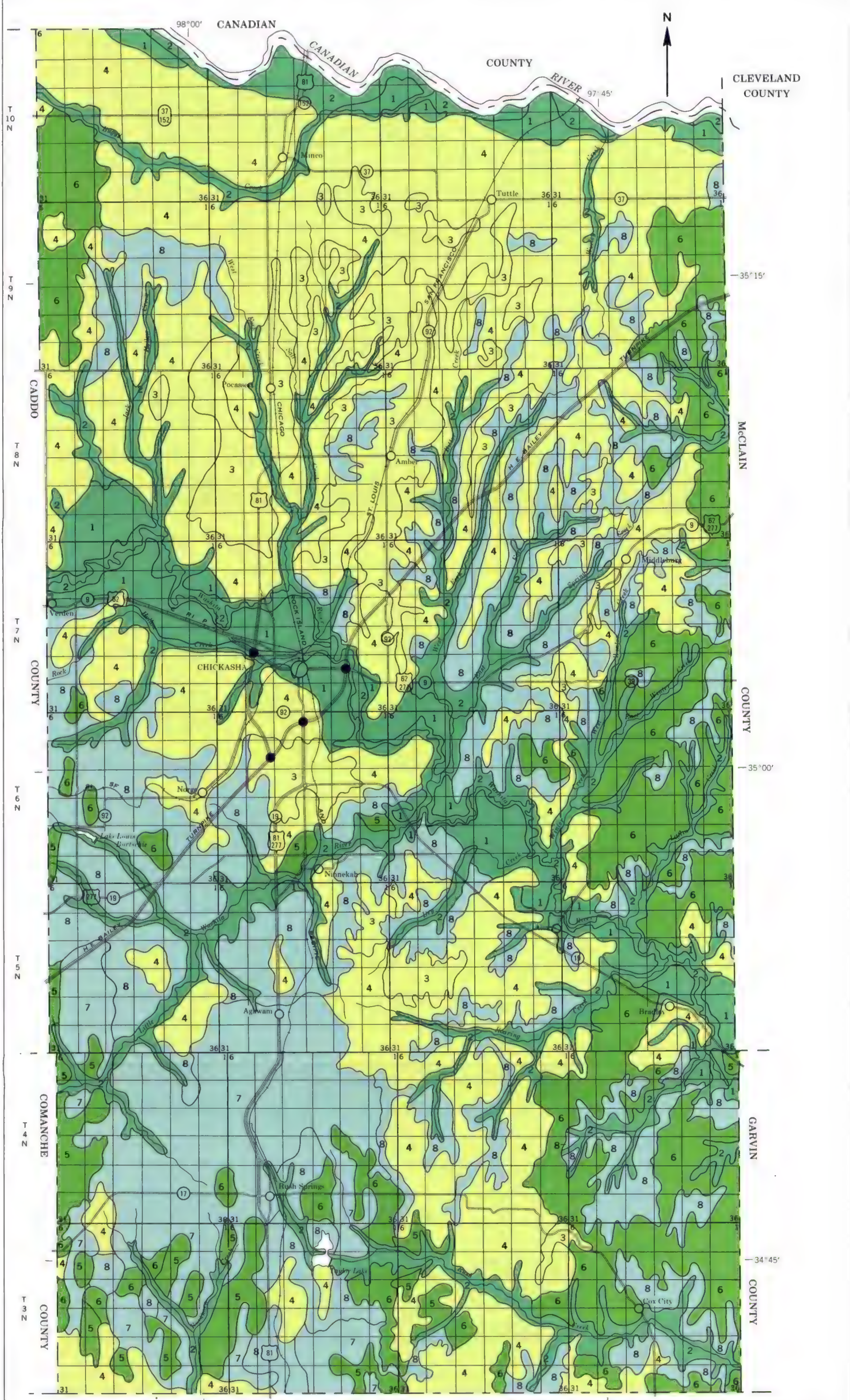
Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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SOIL ASSOCIATIONS*

1 DALE-REINACH-McLAIN association: Nearly level, well drained and moderately well drained loamy soils.

2 PORT-YAHOLA-GRACEMONT association: Nearly level well drained and somewhat poorly drained loamy soils.

3 RENFROW-KIRKLAND-BETHANY association: Nearly level to gently sloping, well drained loamy soils.

4 GRANT-MINCO-ZANEIS association: Nearly level to sloping, well drained loamy soils.

DEEP, LOAMY, MODERATELY RAPIDLY PERMEABLE TO SLOWLY PERMEABLE SOILS ON FLOOD PLAINS

DEEP, LOAMY, MODERATELY PERMEABLE TO VERY SLOWLY PERMEABLE SOILS ON UPLANDS

DEEP AND MODERATELY DEEP, SANDY AND LOAMY, MODERATELY RAPIDLY PERMEABLE TO MODERATELY SLOWLY PERMEABLE SOILS ON UPLANDS

5 KONAHA-DOUGHERTY association: Nearly level to sloping, well drained sandy soils.

6 STEPHENVILLE-NOBLE-WINDTHORST association: Very gently sloping and gently sloping, mainly well drained loamy and sandy soils.

SHALLOW TO DEEP, SANDY AND LOAMY, MODERATELY PERMEABLE TO RAPIDLY PERMEABLE SOILS ON UPLANDS

7 STEPHENVILLE-EUFAULA association: Gently sloping to moderately steep, well drained and somewhat excessively drained loamy and sandy soils.

8 NASH-LUCIEN-STEPHENVILLE association: Very gently sloping to moderately steep, well drained loamy and sandy soils.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
OKLAHOMA AGRICULTURAL EXPERIMENT STATION
GENERAL SOIL MAP
GRADY COUNTY, OKLAHOMA

Scale 1:253,440
1 0 1 2 3 4 Miles

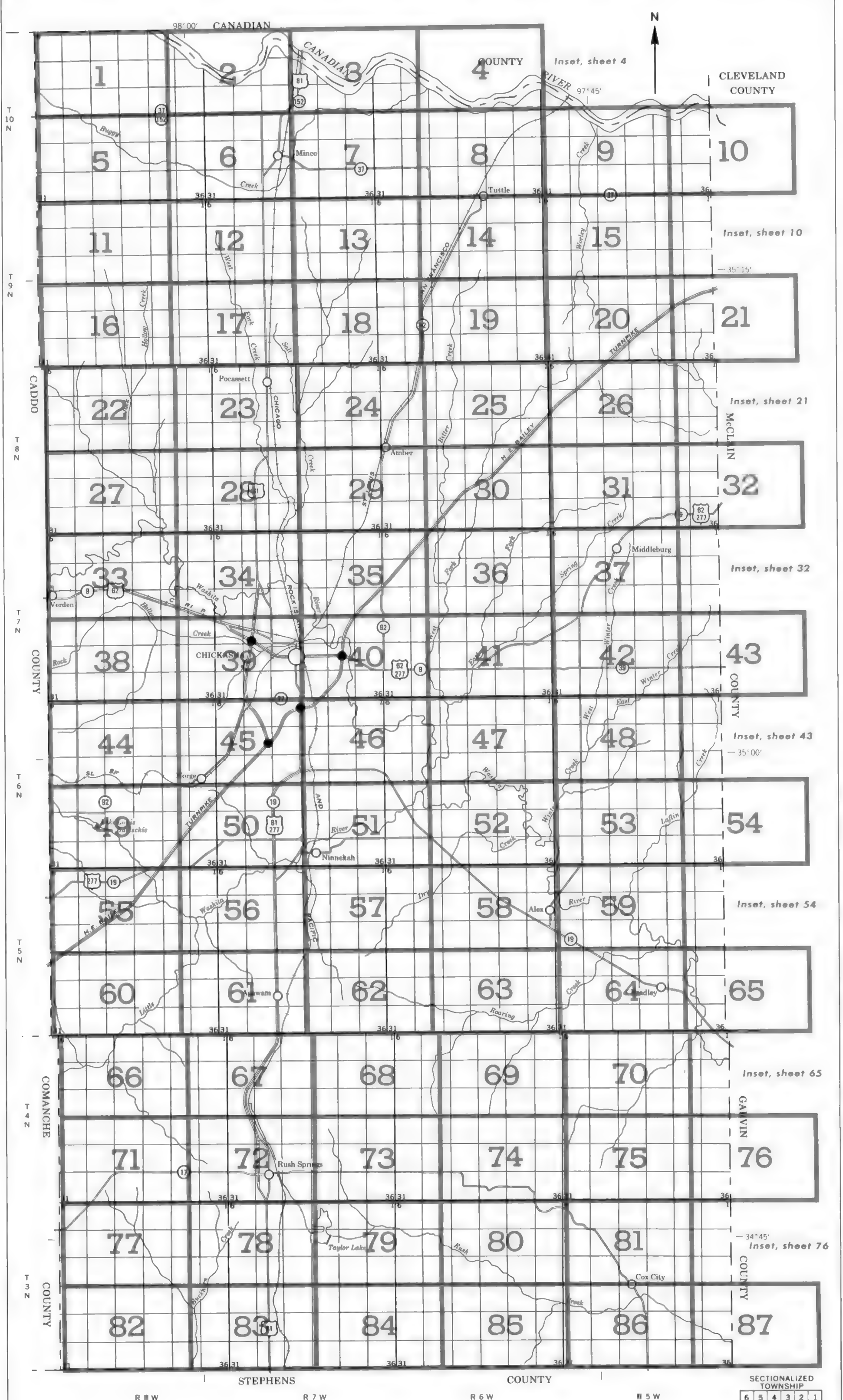
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Compiled 1977

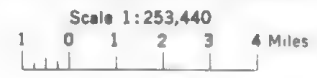
* The terms for texture in the descriptive headings apply to the surface layer of the major soils in each association.

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Original text from each individual map sheet read:
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

**INDEX TO MAP SHEETS
GRADY COUNTY, OKLAHOMA**



SECTIONALIZED TOWNSHIP											
6	5	4	3	2	1						
7	8	9	10	11	12						
18	17	16	15	14	13						
19	20	21	22	23	24						
30	29	28	27	26	25						
31	32	33	34	35	36						

CONVENTIONAL AND SPECIAL
SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES	
National, state or province	
County or parish	
Minor civil division	
Reservation (national forest or park, state forest or park, and large airport)	
Land grant	
Limit of soil survey (label)	
Field sheet matchline & neatline	
AD HOC BOUNDARY (label)	
Small airport, airfield, park, oilfield, cemetery, or flood pool	
STATE COORDINATE TICK	
LAND DIVISION CORNERS (sections and land grants)	
ROADS	
Divided (median shown if scale permits)	
Other roads	
Trail	
ROAD EMBLEMS & DESIGNATIONS	
Interstate	
Federal	
State	
County, farm or ranch	
RAILROAD	
POWER TRANSMISSION LINE (normally not shown)	
PIPE LINE (normally not shown)	
FENCE (normally not shown)	
LEVEES	
Without road	
With road	
With railroad	
DAMS	
Large (to scale)	
Medium or small	

MISCELLANEOUS CULTURAL FEATURES	
Farmstead, house (omit in urban areas)	
Church	
School	
Indian mound (label)	
Located object (label)	
Tank (label)	
Wells, oil or gas	
Windmill	
Kitchen midden	

WATER FEATURES

DRAINAGE	
Perennial, double line	
Perennial, single line	
Intermittent	
Drainage end	
Canals or ditches	
Double-line (label)	
Drainage and/or irrigation	
LAKES, PONDS AND RESERVOIRS	
Perennial	
Intermittent	
MISCELLANEOUS WATER FEATURES	
Marsh or swamp	
Spring	
Well, artesian	
Well, irrigation	
Wet spot	
Sewage disposal	
Water works	
Sewage lagoon (large)	
Sewage lagoon (small)	

SPECIAL SYMBOLS FOR
SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS	
CeA	FeB2
ESCARPMENTS	
Bedrock (points down slope)	
Other than bedrock (points down slope)	
SHORT STEEP SLOPE	
GULLY	
DEPRESSION OR SINK	
SOIL SAMPLE SITE (normally not shown)	
MISCELLANEOUS	
Blowout	
Clay spot	
Gravelly spot	
Gumbo, slick or scabby spot (sodic)	
Dumps and other similar non soil areas	
Prominent hill or peak	
Rock outcrop (includes sandstone and shale)	
Saline spot	
Sandy spot	
Severely eroded spot	
Slide or slip (tips point upslope)	
Stony spot, very stony spot	
PITS	
Gravel pit (small)	
Gravel pit (large)	
Mine or quarry	
Clay pit	

SYMBOL	NAME
1	Amber very fine sandy loam, 1 to 3 percent slopes
2	Bethany silt loam, 0 to 1 percent slopes
3	Cyril fine sandy loam
4	Dale silt loam
5	Darnell-Noble complex, 8 to 20 percent slopes
6	Dougherty fine sand, 0 to 3 percent slopes
7	Dougherty-Eufaula complex, 3 to 8 percent slopes
8	Eufaula fine sand, 5 to 12 percent slopes
9	Eufaula-Stephenville complex, 8 to 20 percent slopes
10	Gracemont fine sandy loam
11	Gracemore soils
12	Grant silt loam, 1 to 3 percent slopes
13	Grant silt loam, 3 to 5 percent slopes
14	Grant silt loam, 2 to 5 percent slopes, eroded
15	Grant-Port complex, 0 to 12 percent slopes
16	Keokuk very fine sandy loam
17	Kirkland silt loam, 0 to 1 percent slopes
18	Konawa loamy fine sand, 0 to 3 percent slopes
19	Konawa-Stephenville complex, 2 to 8 percent slopes, severely eroded
20	Lela silty clay
21	Lucien-Nash complex, 5 to 12 percent slopes
22	McLain silty clay loam
23	Minco very fine sandy loam, 5 to 8 percent slopes
24	Minco very fine sandy loam, 8 to 30 percent slopes
25	Minco silt loam, 0 to 1 percent slopes
26	Minco silt loam, 1 to 3 percent slopes
27	Minco silt loam, 3 to 5 percent slopes
28	Nash loam, 3 to 5 percent slopes
29	Nash loam, 5 to 8 percent slopes
30	Nash-Lucien complex, 1 to 5 percent slopes
31	Noble fine sandy loam, 1 to 3 percent slopes
32	Noble-Darnell complex, 3 to 5 percent slopes
33	Norge silt loam, 0 to 1 percent slopes
34	Norge silt loam, 1 to 3 percent slopes
35	Norge silt loam, 2 to 5 percent slopes, eroded
36	Pocasset silty clay loam
37	Pond Creek silt loam, 0 to 1 percent slopes
38	Pond Creek silt loam, 1 to 3 percent slopes
39	Port fine sandy loam, overwash
40	Port silt loam
41	Pulaski fine sandy loam
42	Quinlan-Rock outcrop complex, 12 to 30 percent slopes
43	Reinach silt loam
44	Renfrow silt loam, 1 to 3 percent slopes
45	Renfrow silt loam, 2 to 5 percent slopes, eroded
46	Renfrow silt loam, 2 to 5 percent slopes, severely eroded
47	Renfrow-Hinkle complex, 1 to 3 percent slopes
48	Stephenville fine sandy loam, 1 to 3 percent slopes
49	Stephenville fine sandy loam, 3 to 5 percent slopes
50	Stephenville fine sandy loam, 2 to 5 percent slopes, eroded
51	Stephenville fine sandy loam, 2 to 8 percent slopes, severely eroded
52	Stephenville-Darnell complex, 1 to 8 percent slopes
53	Stephenville-Eufaula complex, 3 to 8 percent slopes
54	Stephenville-Pulaski complex, 0 to 12 percent slopes
55	Teller loam, 1 to 3 percent slopes
56	Teller loam, 3 to 5 percent slopes
57	Teller loam, 2 to 5 percent slopes, eroded
58	Teller loam, 5 to 8 percent slopes
59	Tivoli loamy fine sand
60	Windthorst fine sandy loam, 1 to 3 percent slopes
61	Windthorst fine sandy loam, 2 to 5 percent slopes, eroded
62	Yahola fine sandy loam
63	Zaneis loam, 1 to 3 percent slopes
64	Zaneis loam, 3 to 5 percent slopes
65	Zaneis loam, 2 to 5 percent slopes, eroded
66	Zaneis loam, 2 to 8 percent slopes, severely eroded



1 Mile
5000 Feet

Scale 1:20000



(Joins sheet 2)

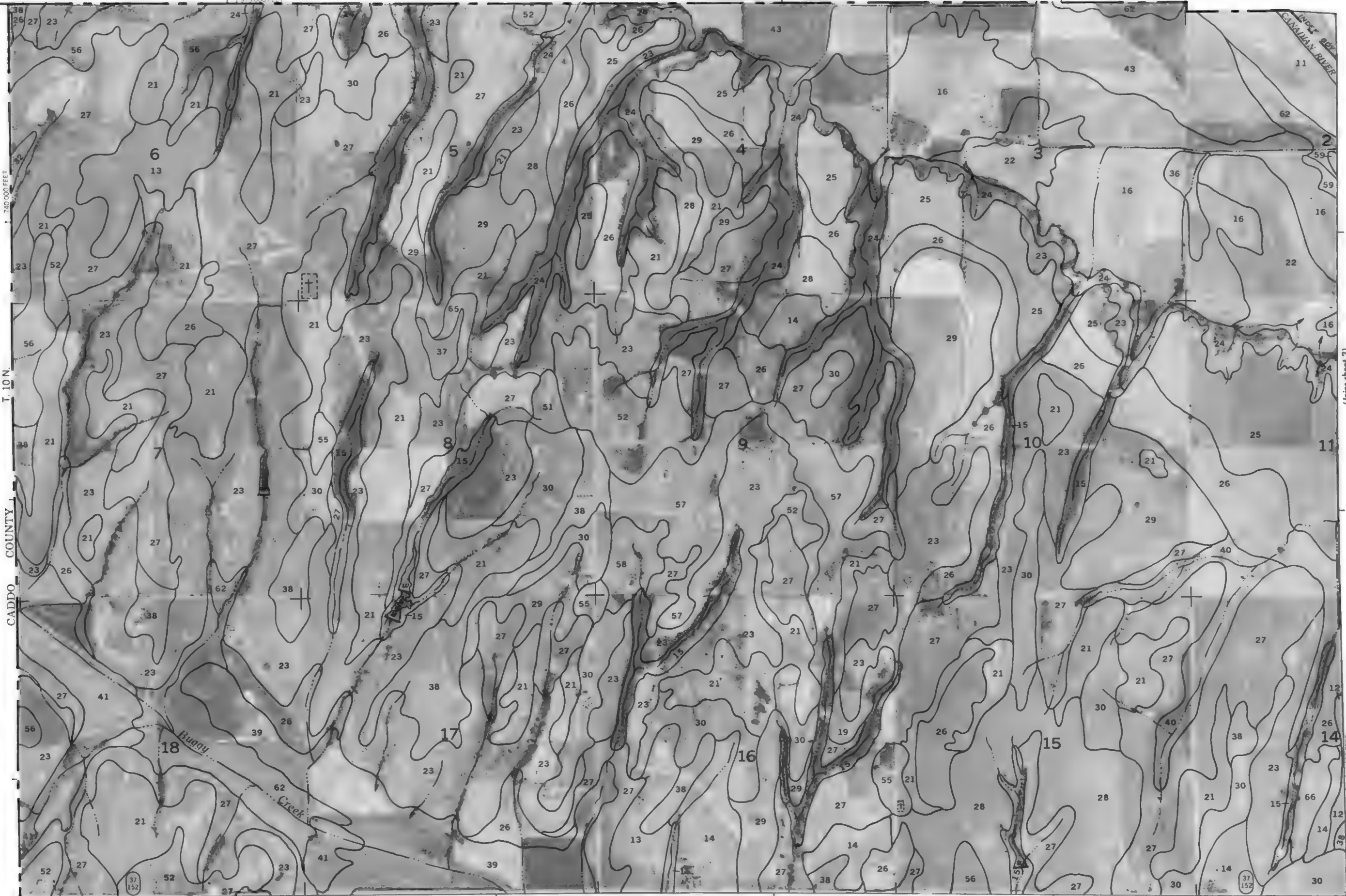
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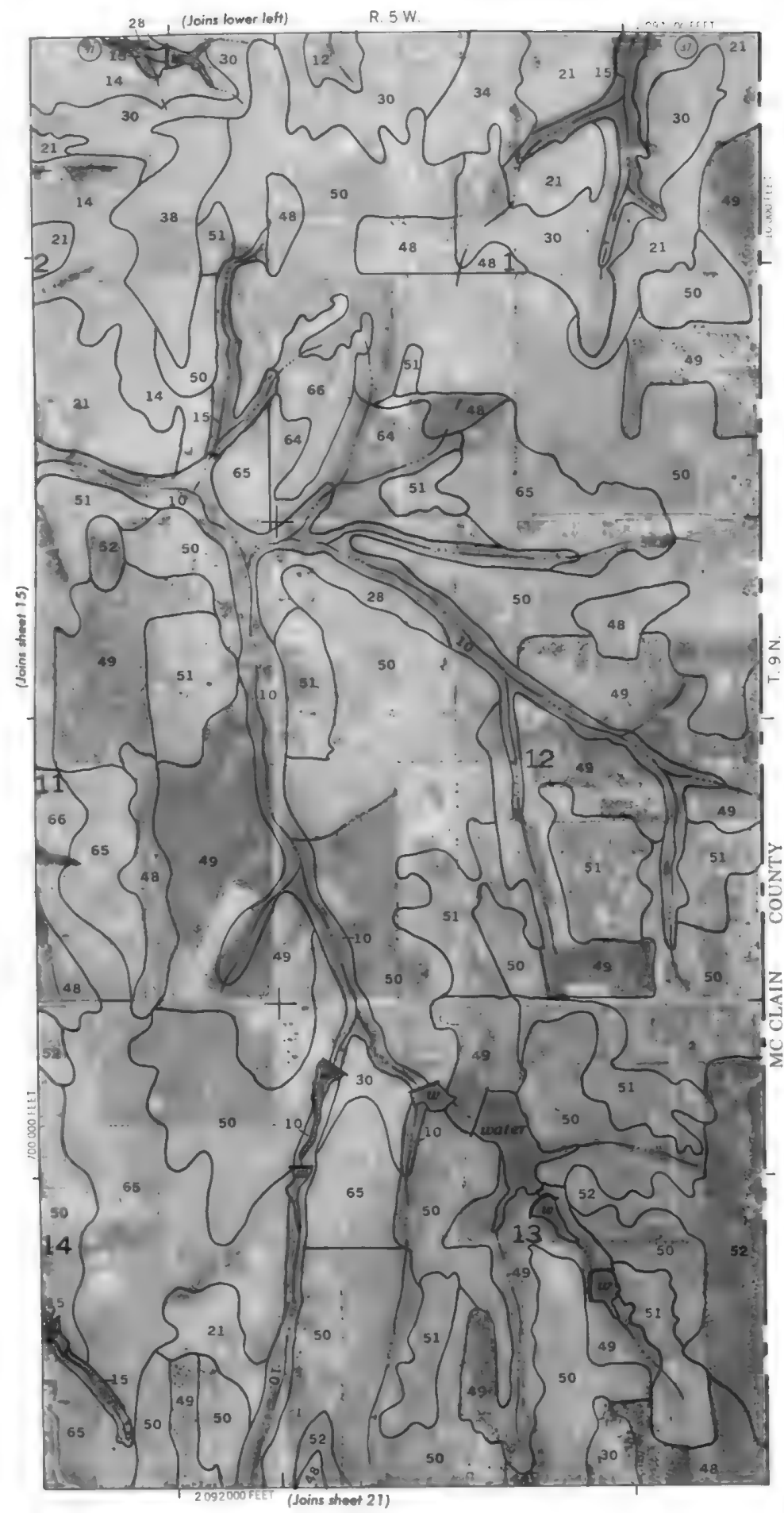
Lower Canadian River

1975 000 FEET

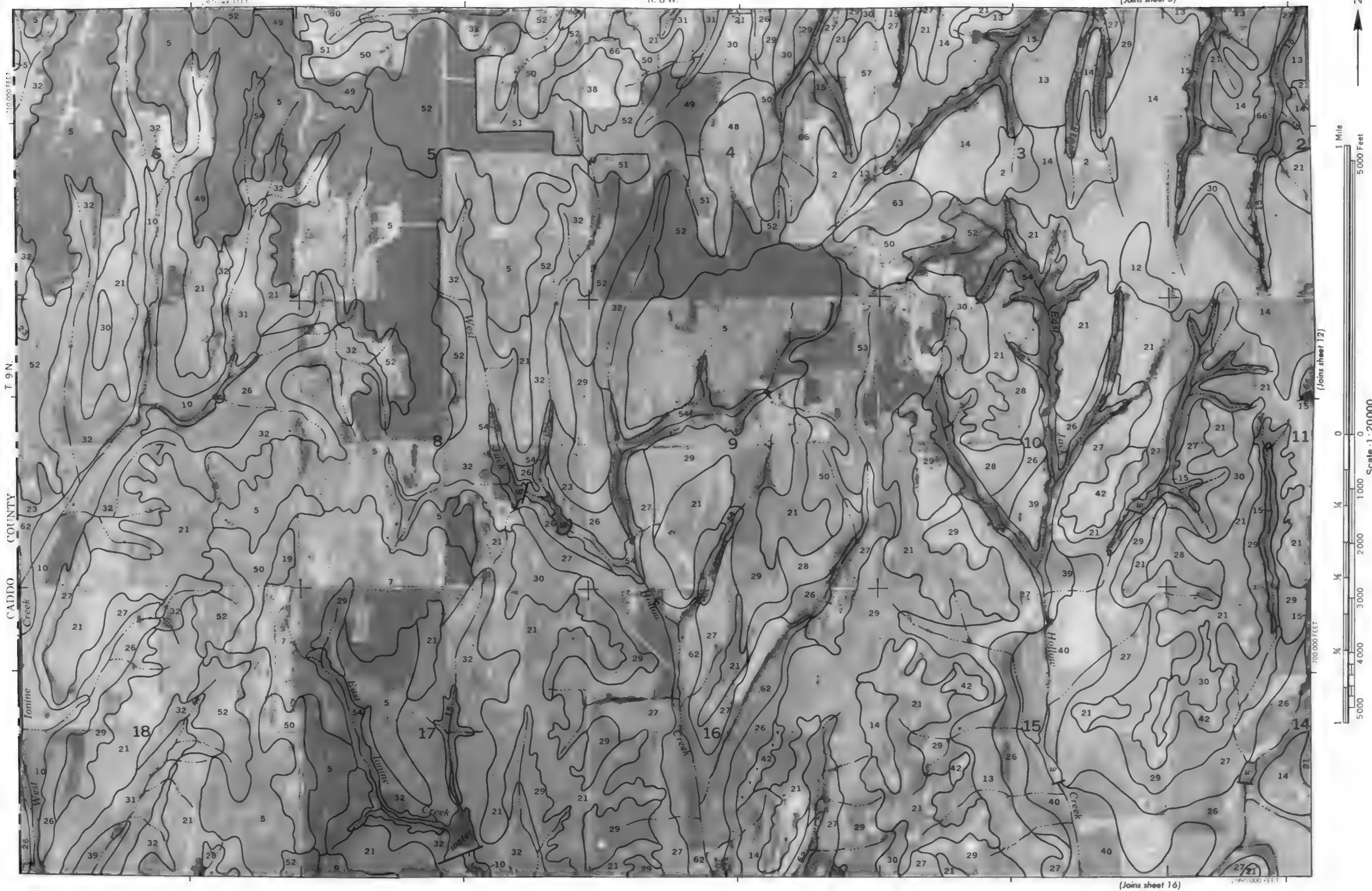
1995 000 FEET

T. 10 N.
CADDO COUNTY





(Joins sheet 5)





(Joins sheet 6)

R. 8 W. | R. 7 W.

2 015 000 FEET



Scale 1:20000

(Joins sheet 11)

700 000 FEET

(Joins sheet 17)

2 000 000 FEET



700 000 FEET

T. 9 N.

(Joins sheet 13)

R. 7 W. | R. 6 W.

(Joins sheet 7)

2 020 000 FEET



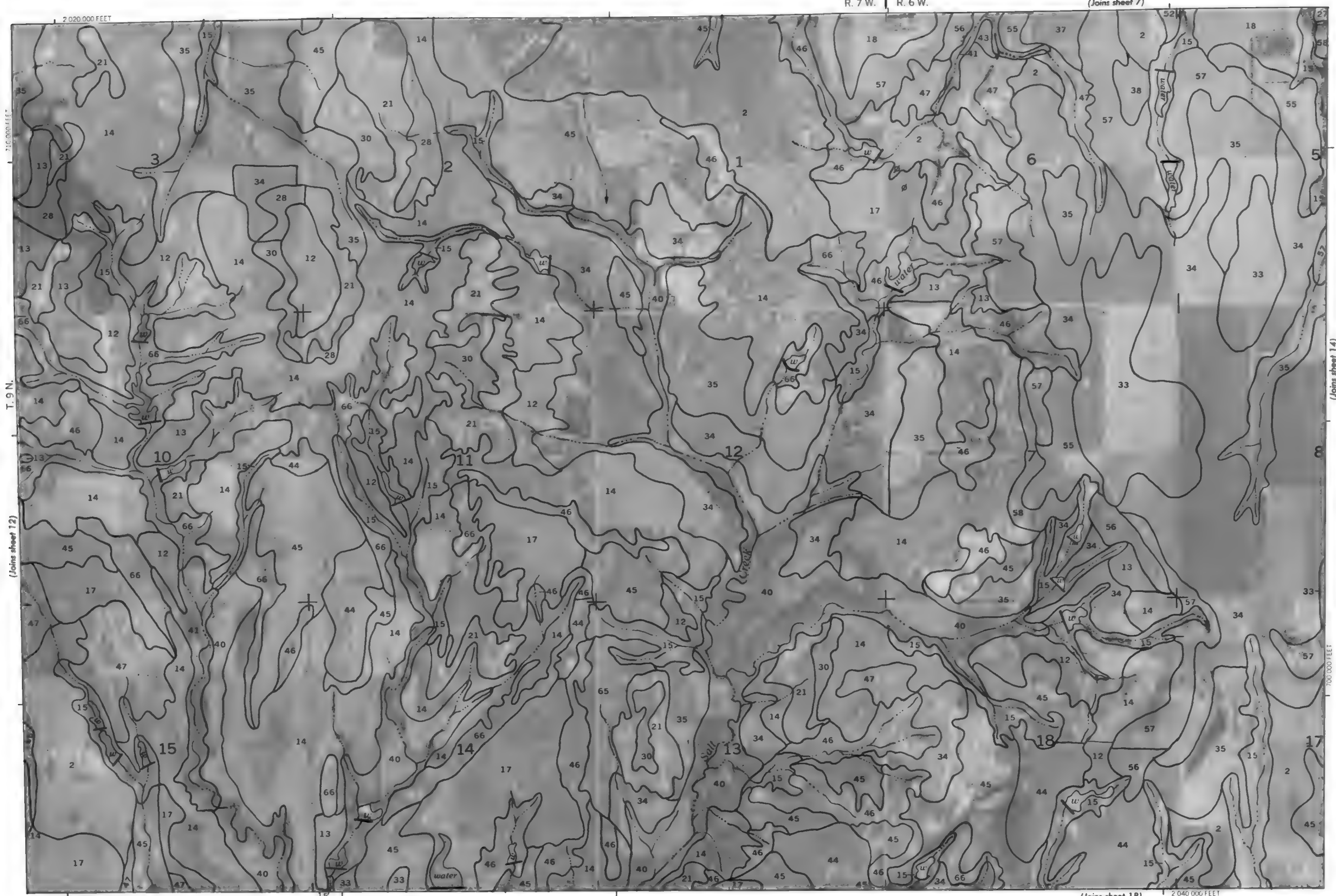
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(Joins sheet 14)

200 000 FEET

(Joins sheet 18)

2 040 000 FEET

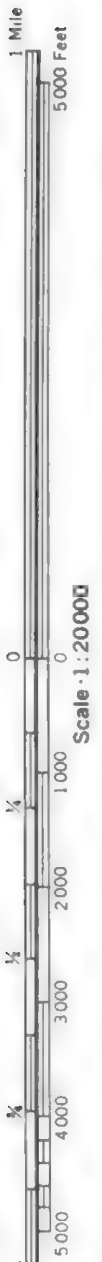




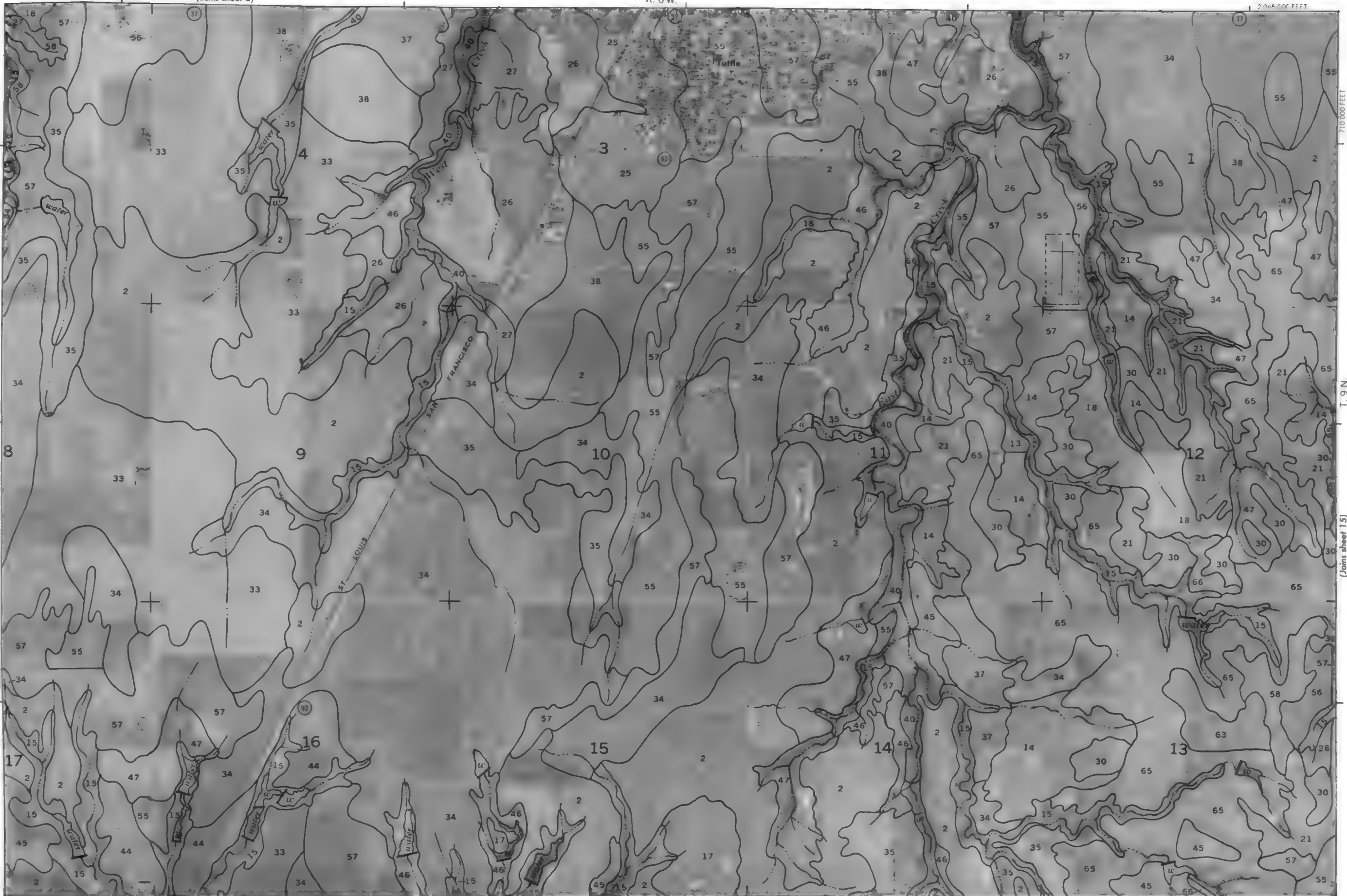
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R. 6 W.

2045 000 FEET



(Joins sheet 13)



2045 000 FEET (Joins sheet 19)

(Joins sheet 15)

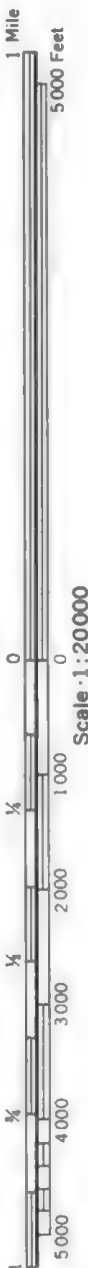
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R. 5 W.

(Joins sheet 9)

2 070 000 FEET

2 090 000 FEET

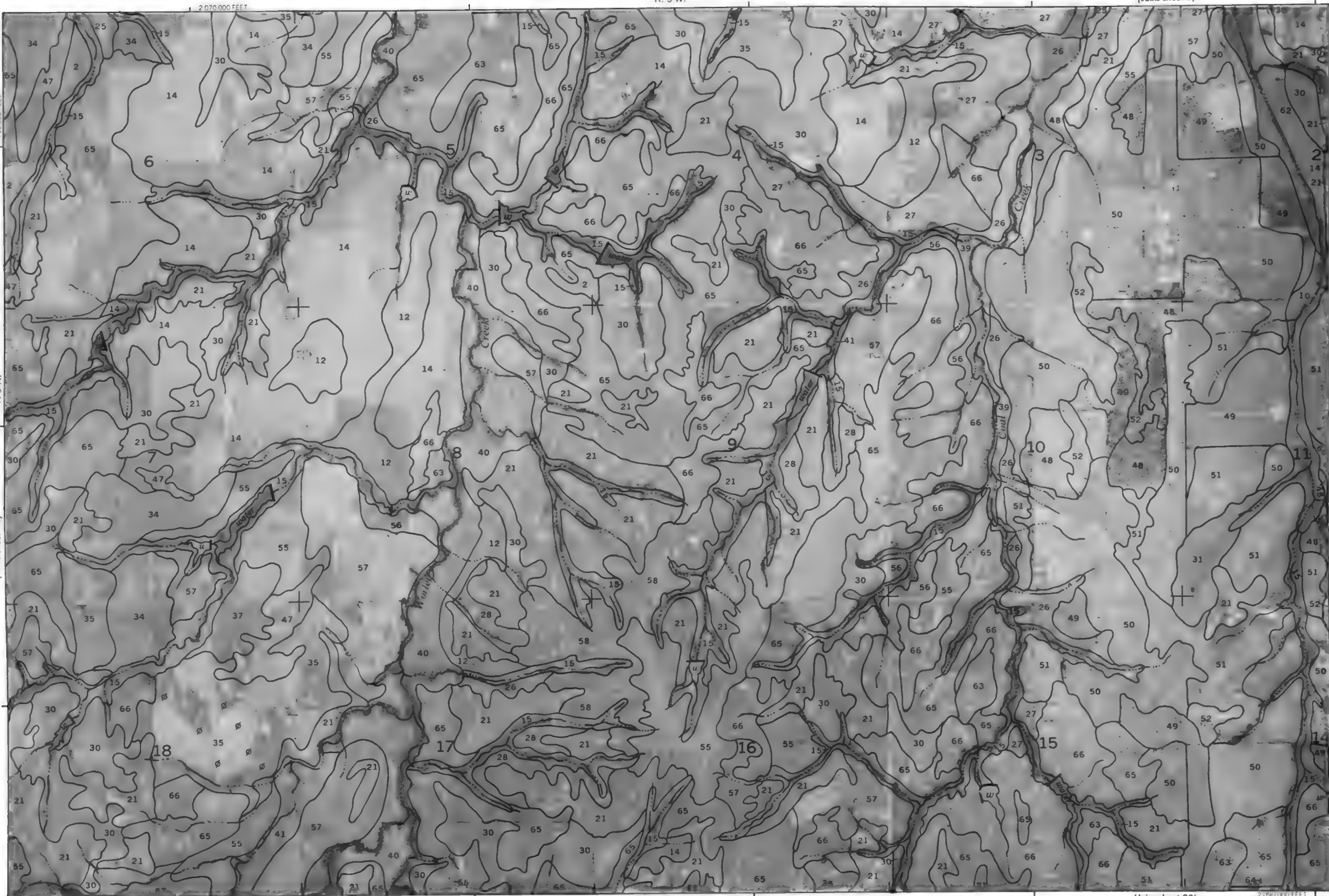


(Joins inset, sheet 10)

(Joins sheet 14)

700 000 FEET

(Joins sheet 20)





(Joins sheet 11)

R. 8 W.

1 995 000 FEET



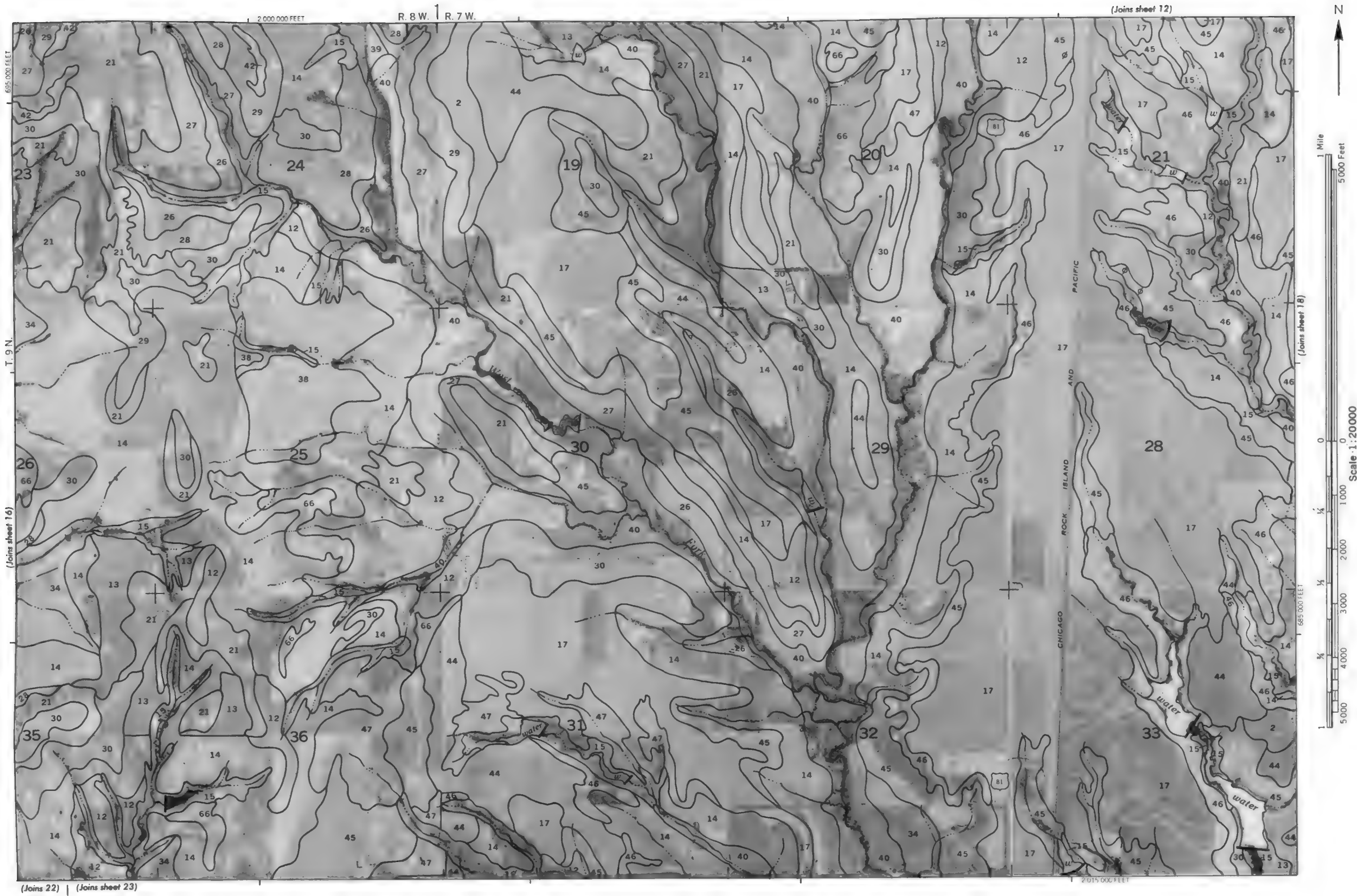
CADDO COUNTY



1 975 000 FEET (Joins sheet 22)

(Joins sheet 17)

T. 9 N.

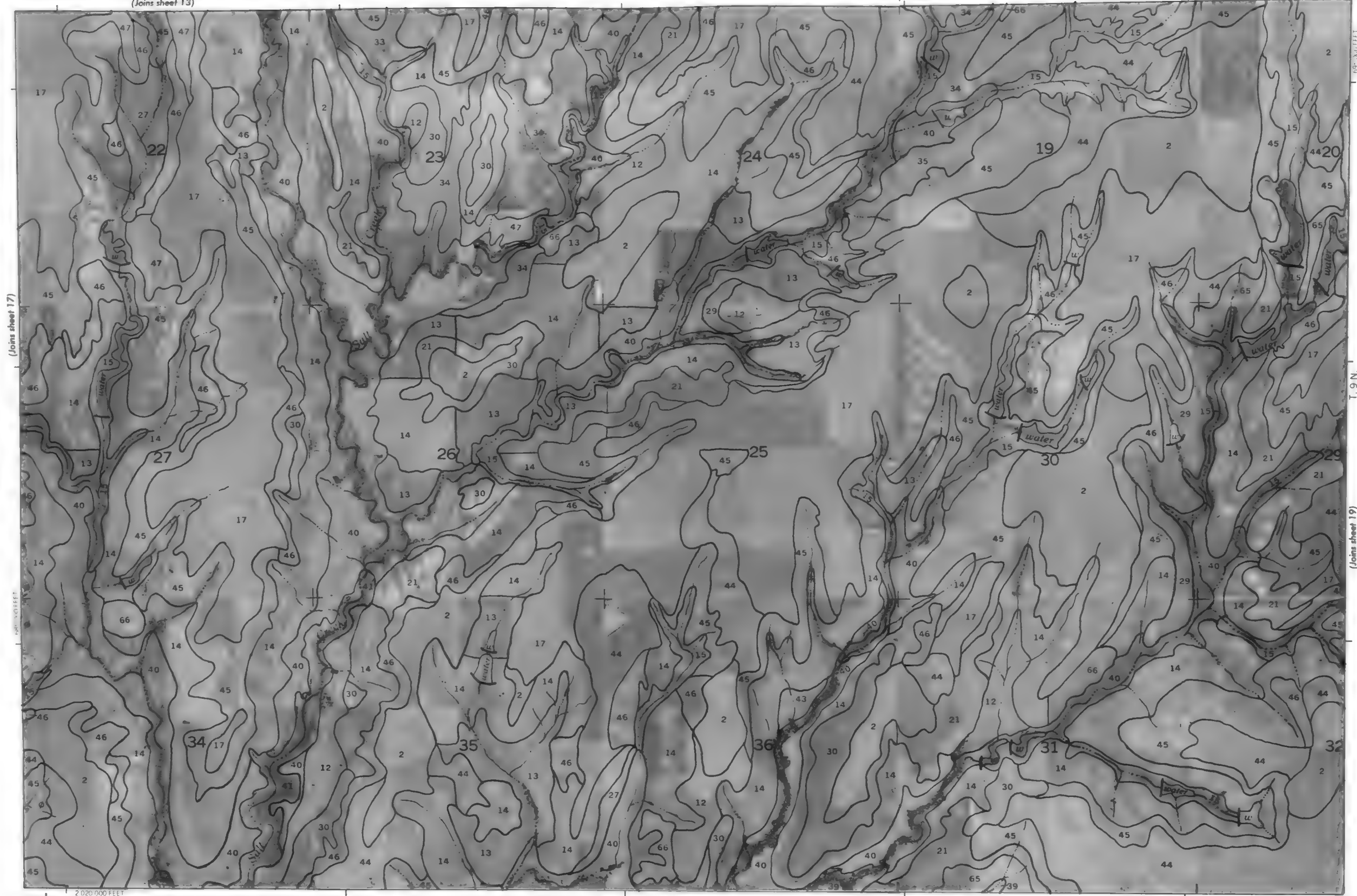
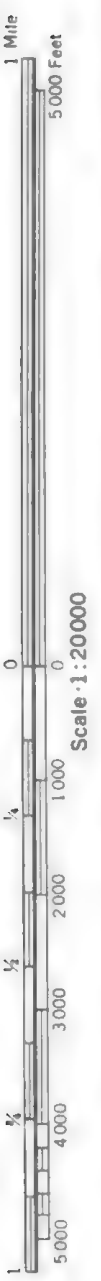




R. 7 W. | R. 6 W.

2 040 000 FEET

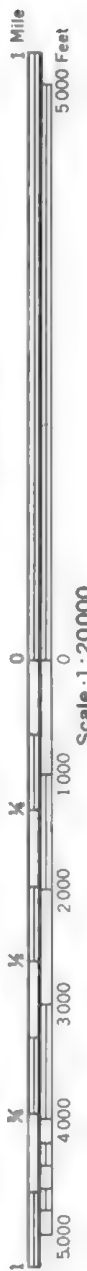
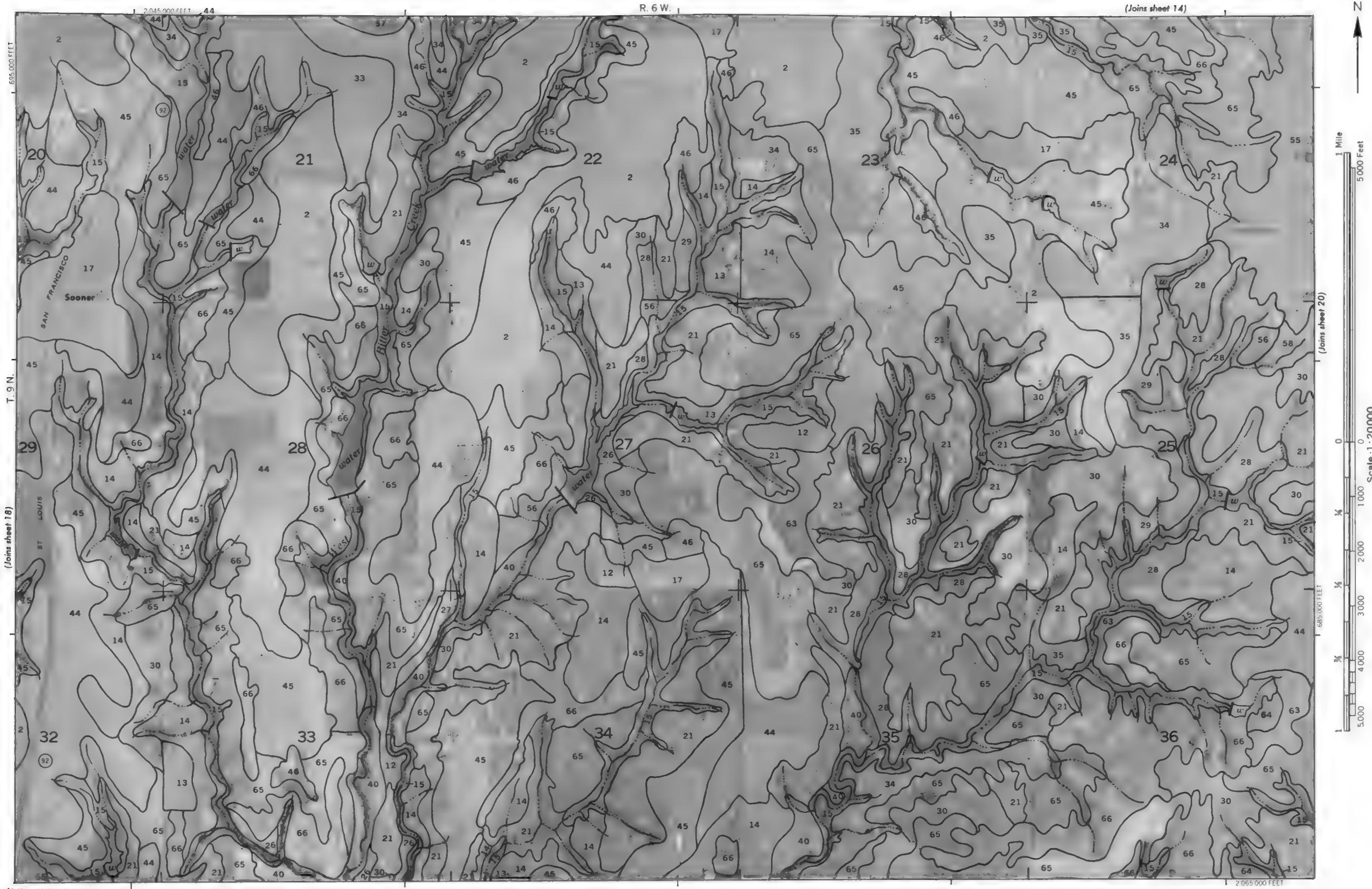
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(23) | (Joins sheet 24)

(Joins sheet 19)

T. 9 N.

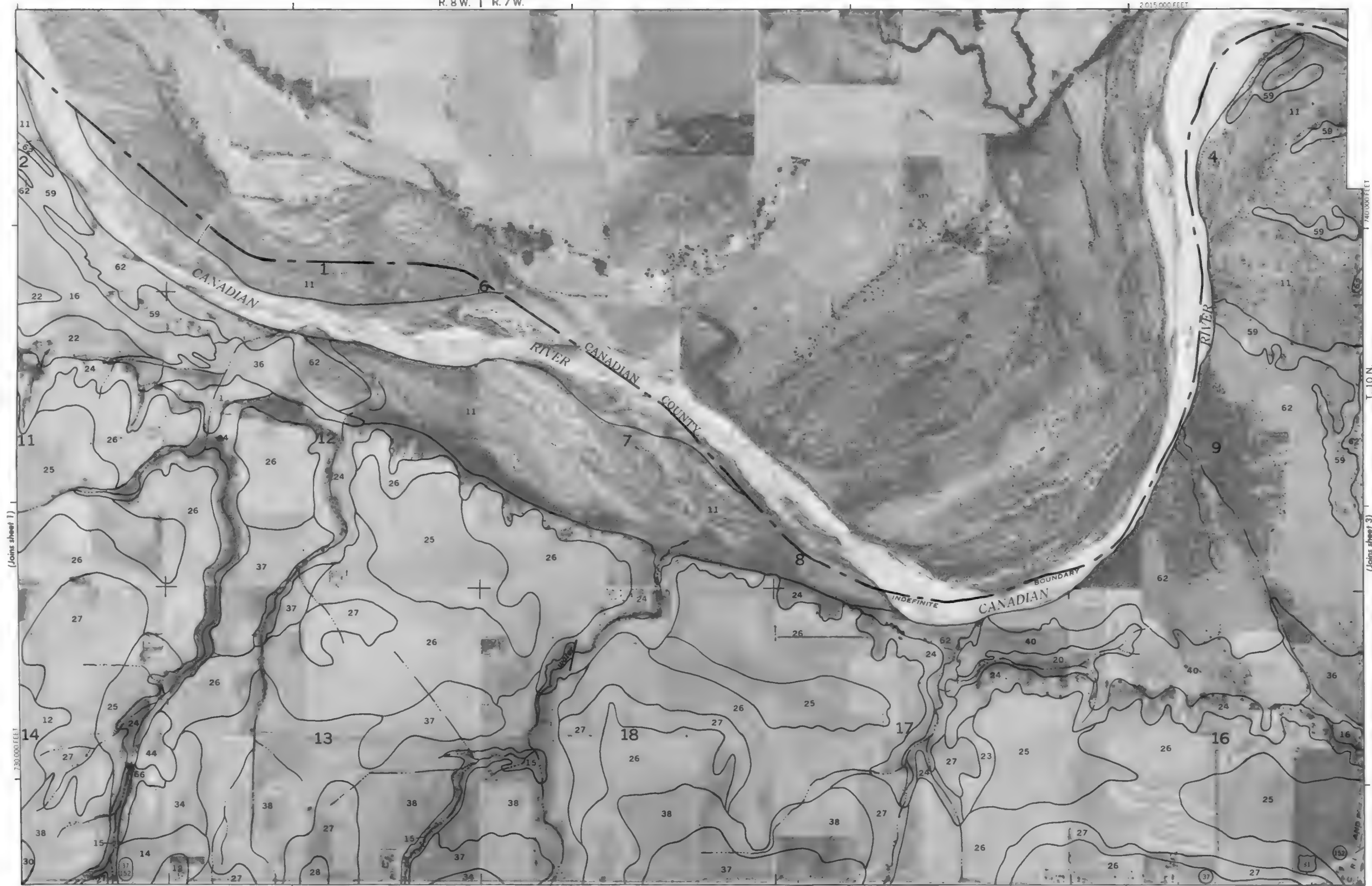
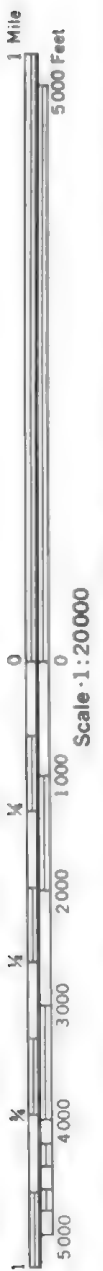


2



R. 8 W. | R. 7 W.

2 015 000 FEET



(Joins sheet 1)

(Joins sheet 3)

(Joins sheet 6)

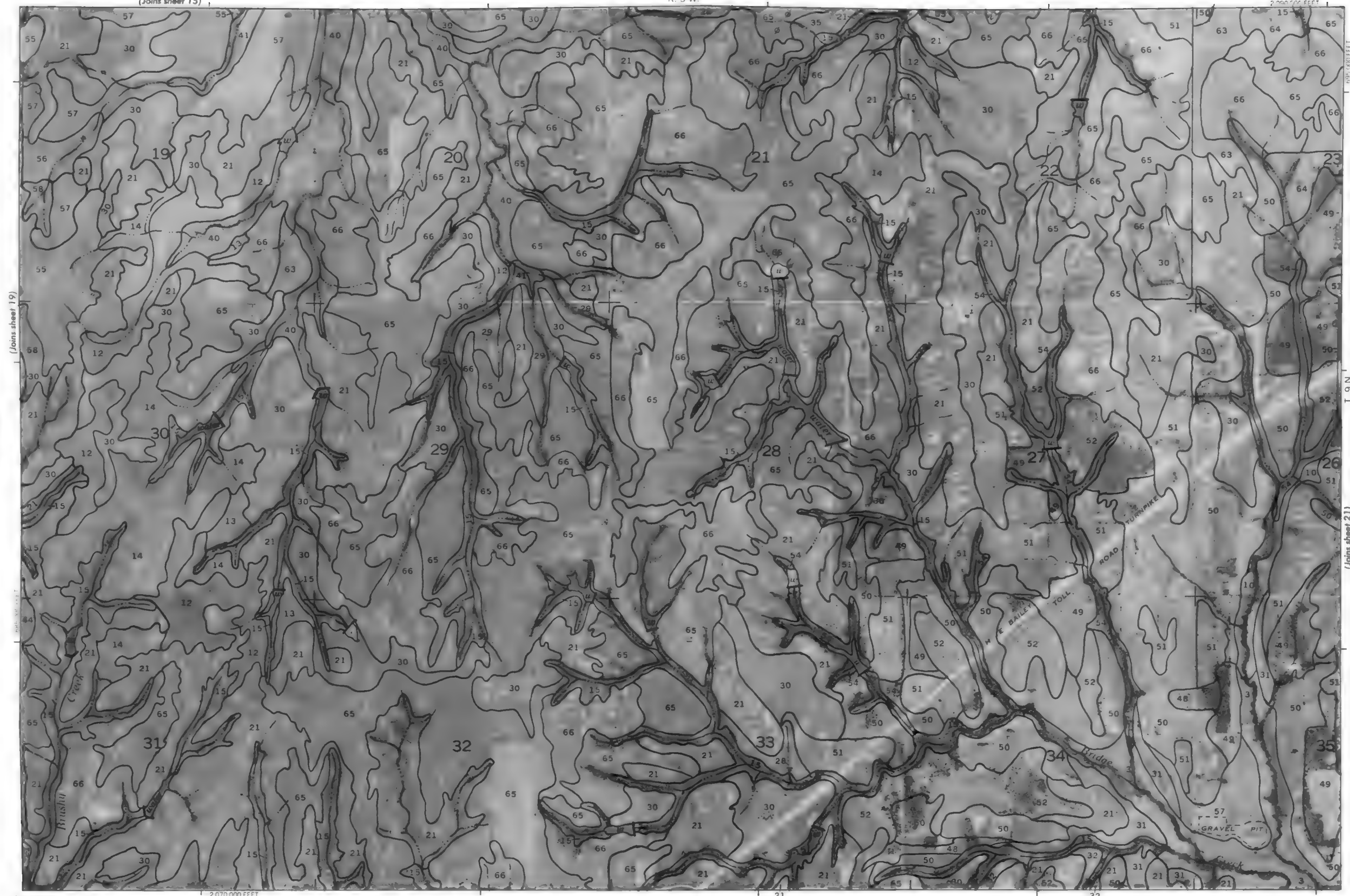
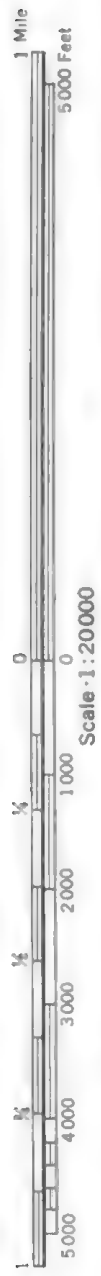
2 000 000 FEET

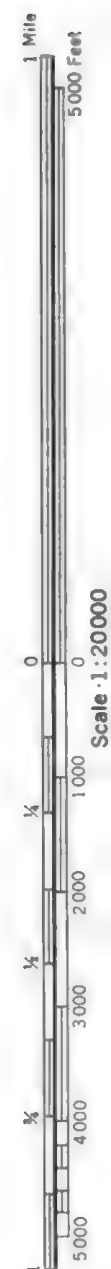
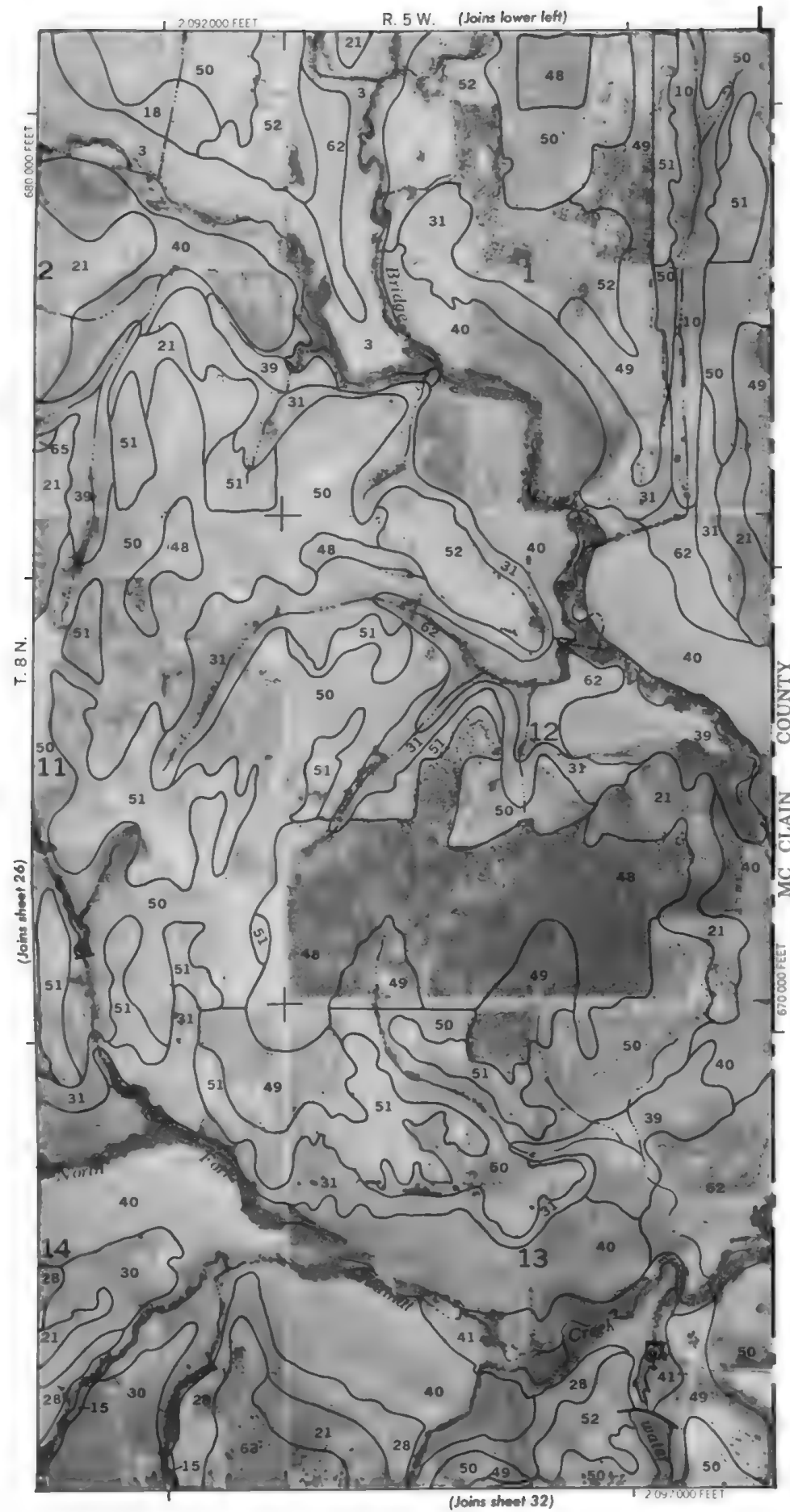
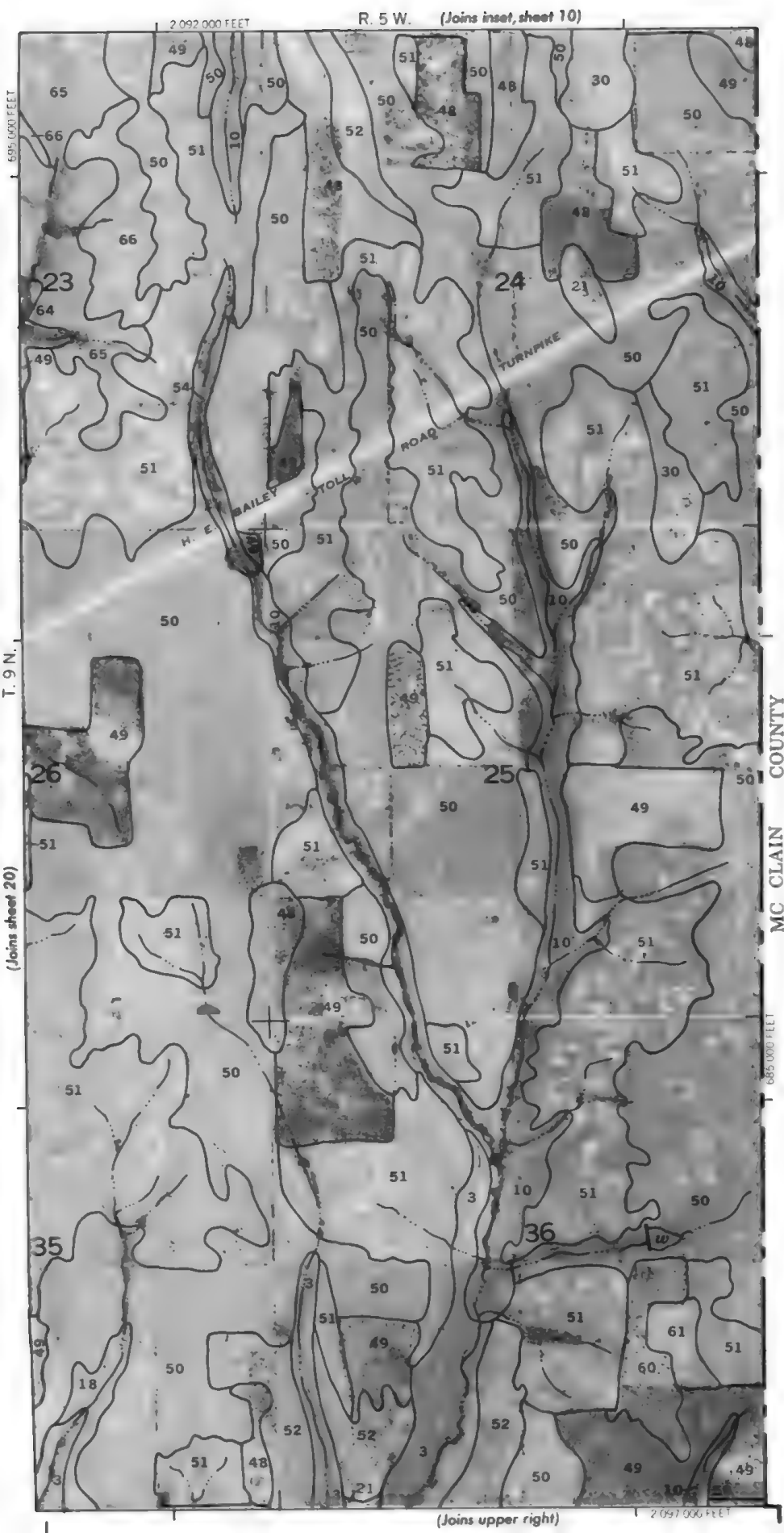


(Joins sheet 15)

R. 5 W.

2 000 000 FEET

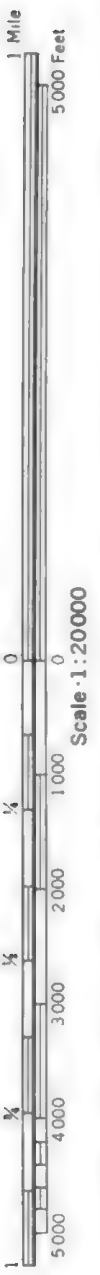






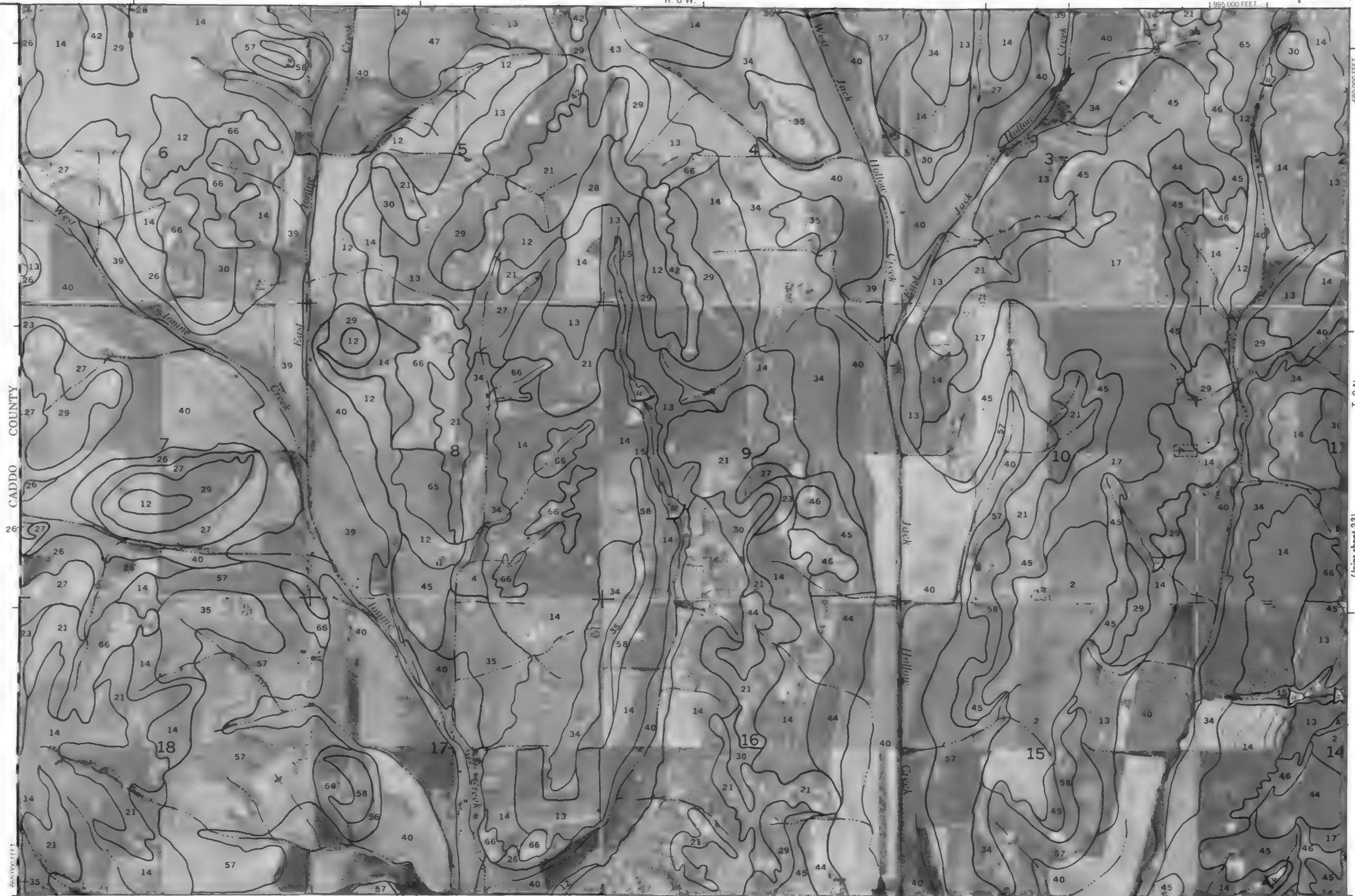
R. 8 W.

(Joins sheet 16) (sheet 17)
1995 000 FEET



Scale 1:20000

CADDO COUNTY



T. 8 N.
(Joins sheet 23)

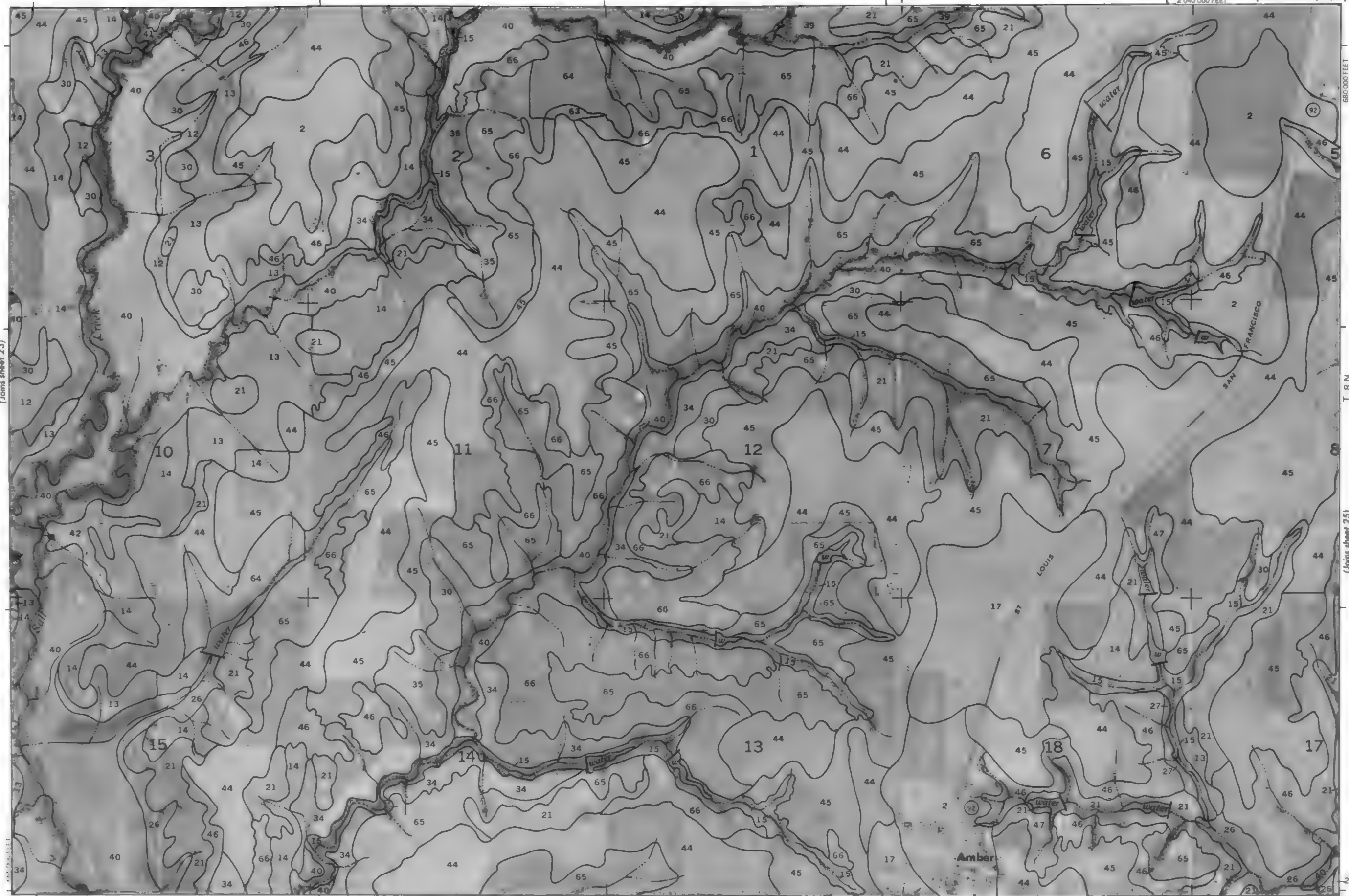
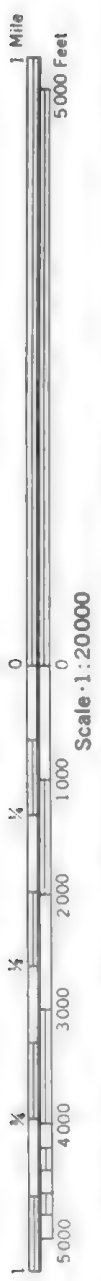
(Joins sheet 27)



R. 7 W. | R. 6 W.

1:204000 FEET

(Joins sheet 18) | (19)

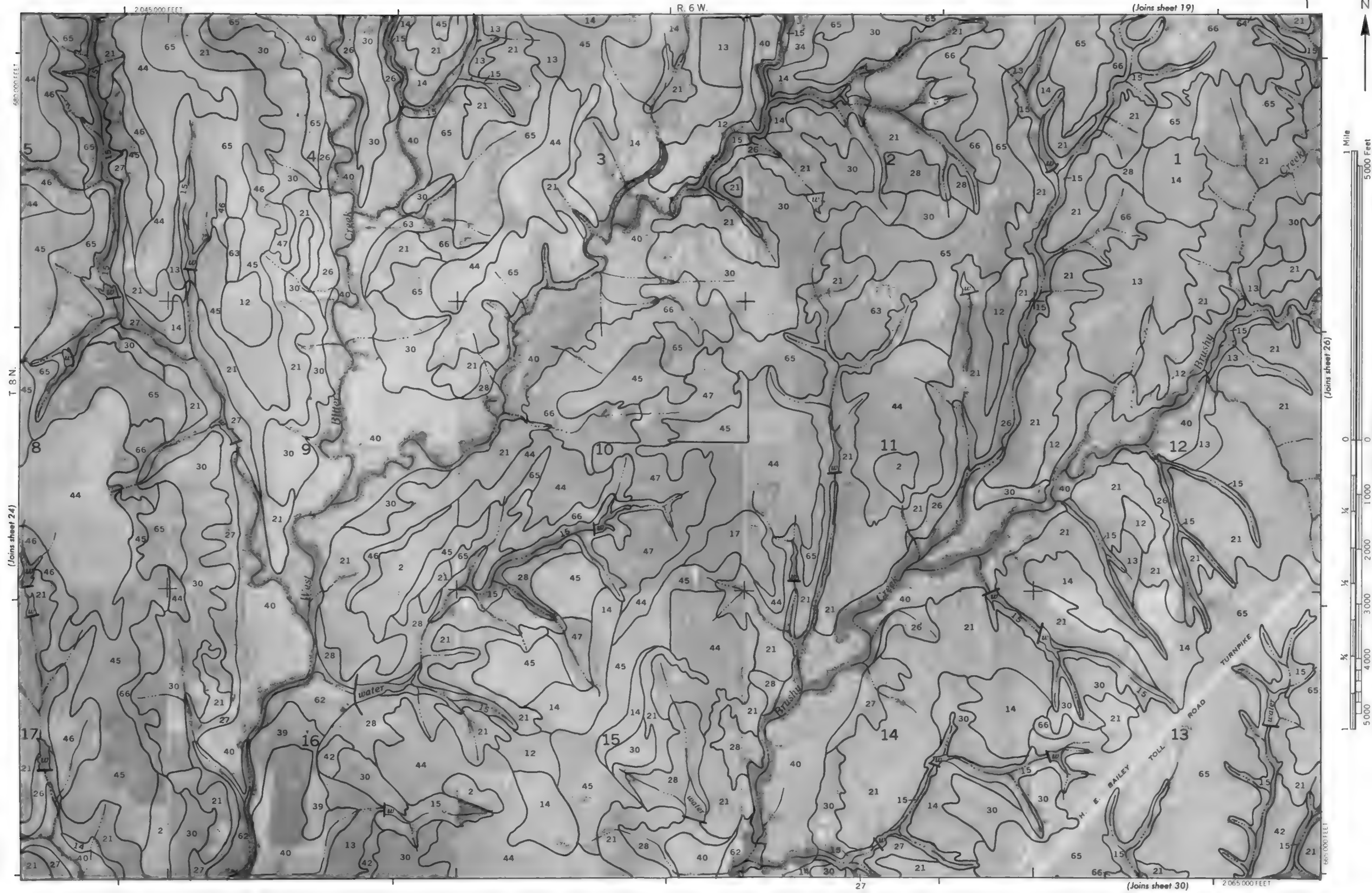


680 000 FEET

(Joins sheet 25)

T. 8 N.

(Joins sheet 29)



(Joins sheet 24)

(Joins sheet 19)

(Joins sheet 26)

(Joins sheet 30)

(Joins sheet 30)

(Joins sheet 30)

6



(Joins sheet 20)

R. 5 W.

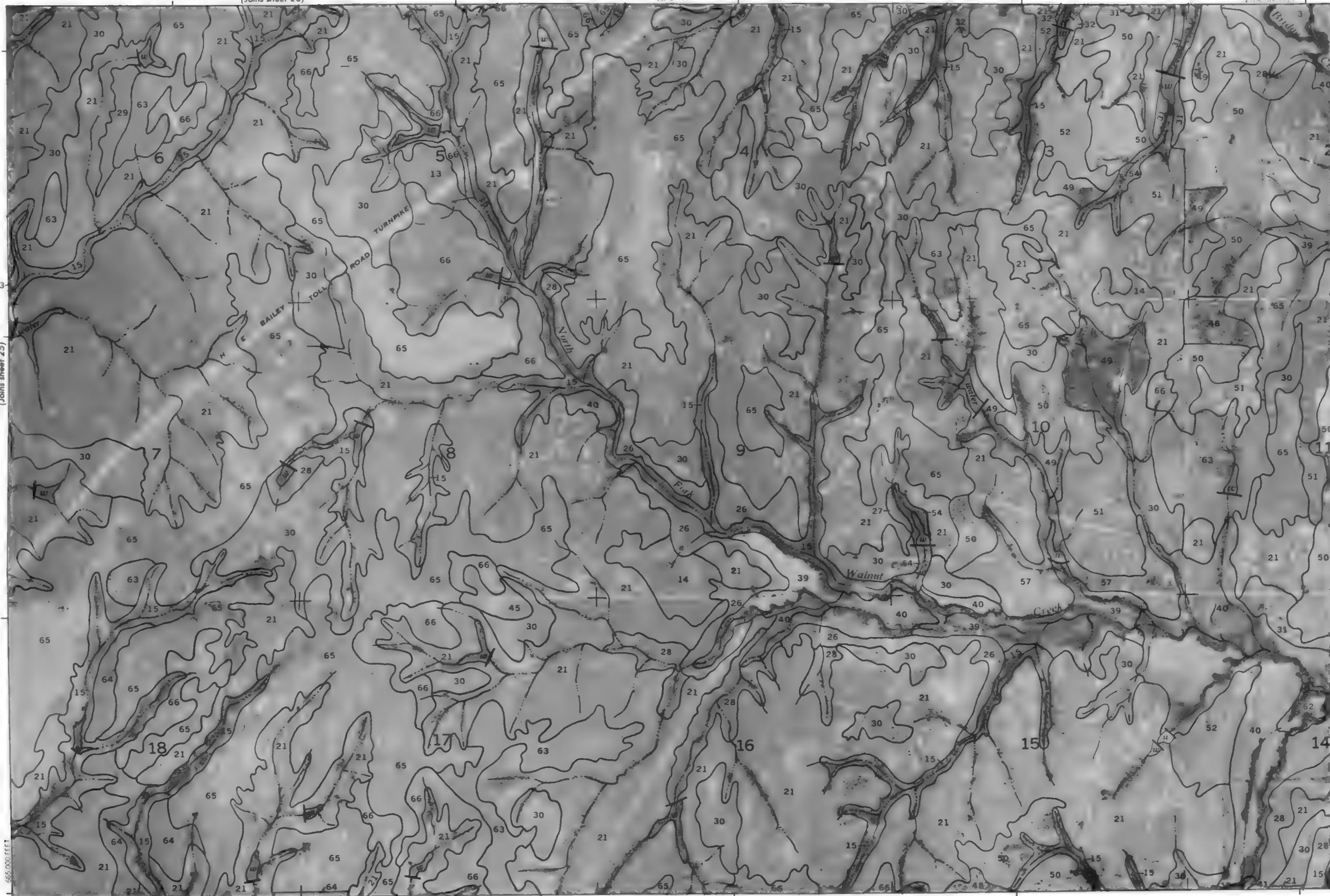
2 000 000 FEET

5000 Feet

Scale: 1:20000

0 1000 2000 3000 4000 5000

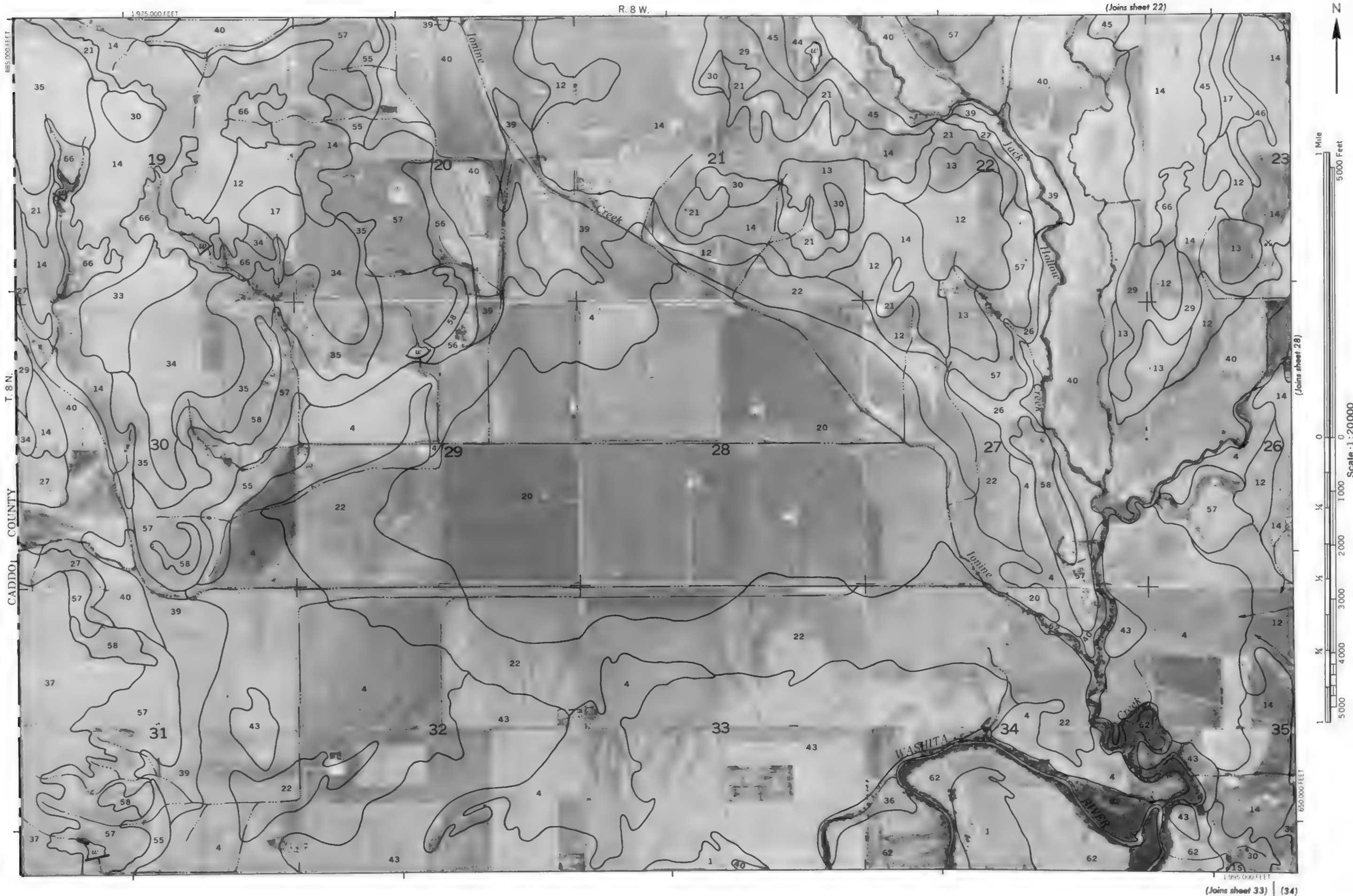
(Joins sheet 25)



2 070 000 FEET (Joins sheet 31)

(Joins inset, sheet 21)

T. 8 N.





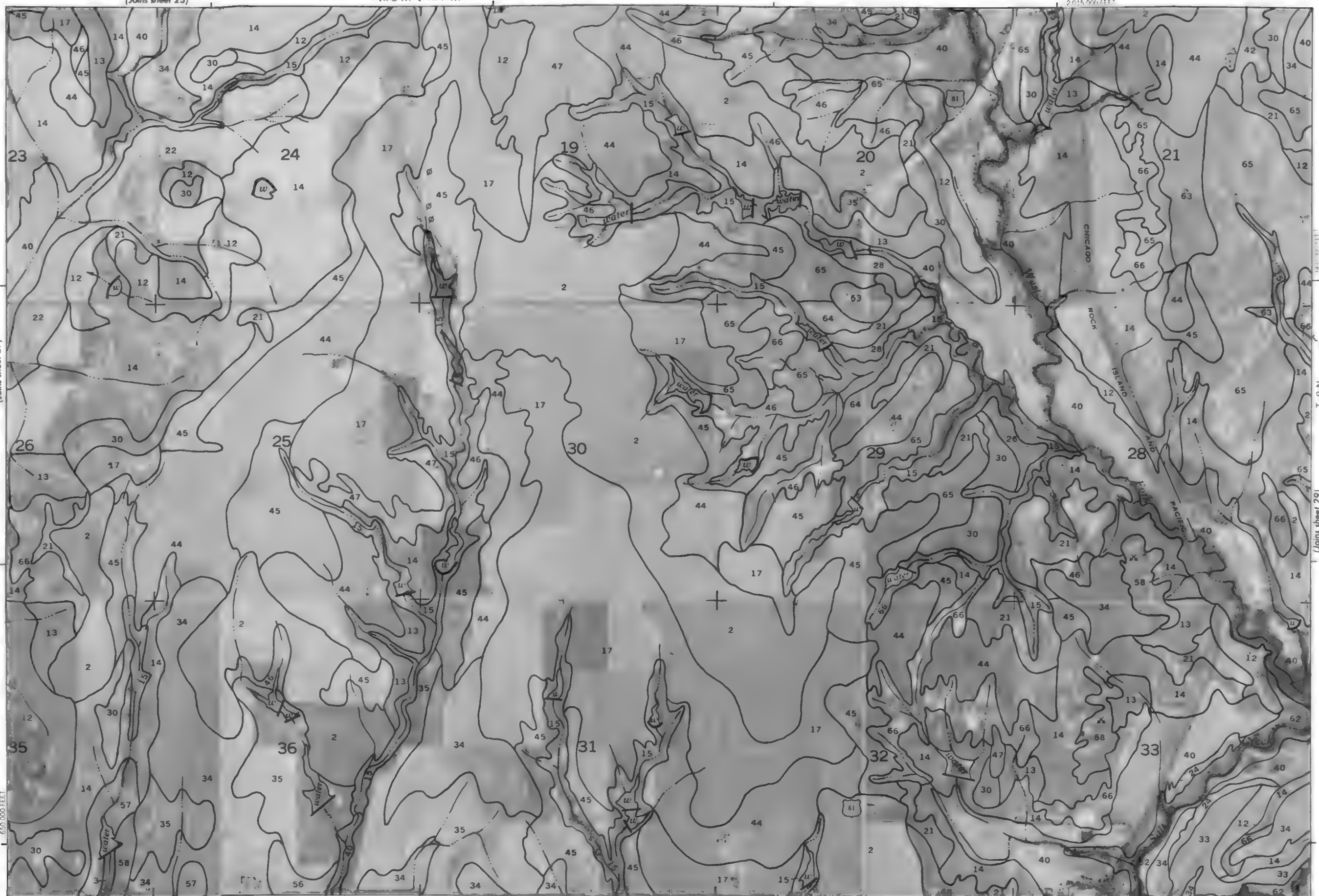
(Joins sheet 23)

R. 8 W. | R. 7 W.

2015 000 FEET



(Joins sheet 27)



(Joins sheet 29)

(Joins sheet 34)

2 000 000 FEET

R. 7 W.

R. 6 W.

(Joins sheet 24)

29



1 Mile
5000 Feet

Scale 1:20000

656,000 FEET

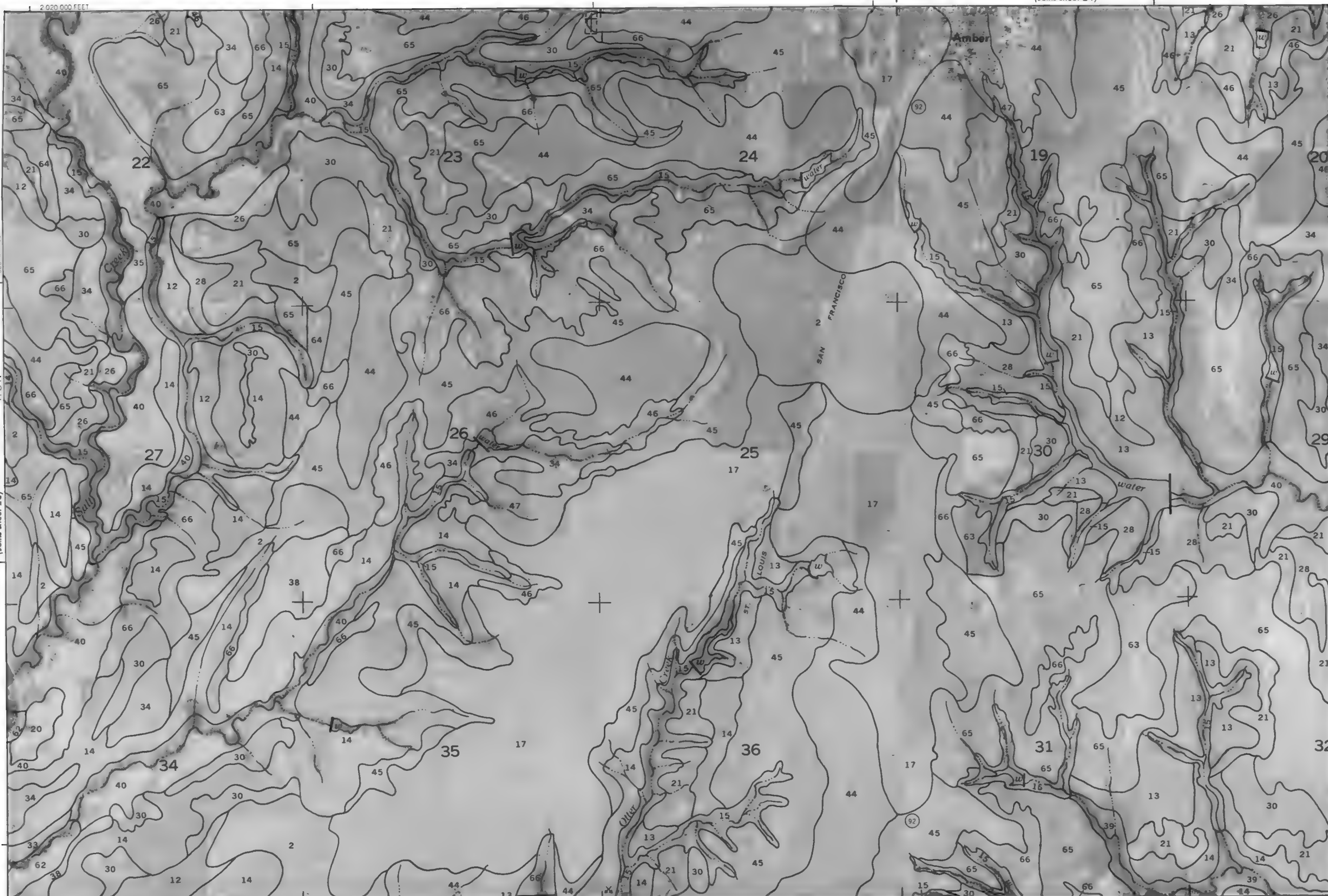
2 020 000 FEET

2 040 000 FEET

T. 8 N
(Joins sheet 28)

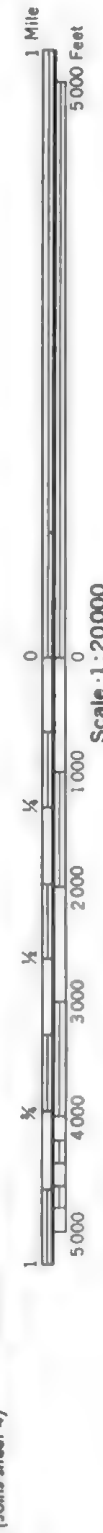
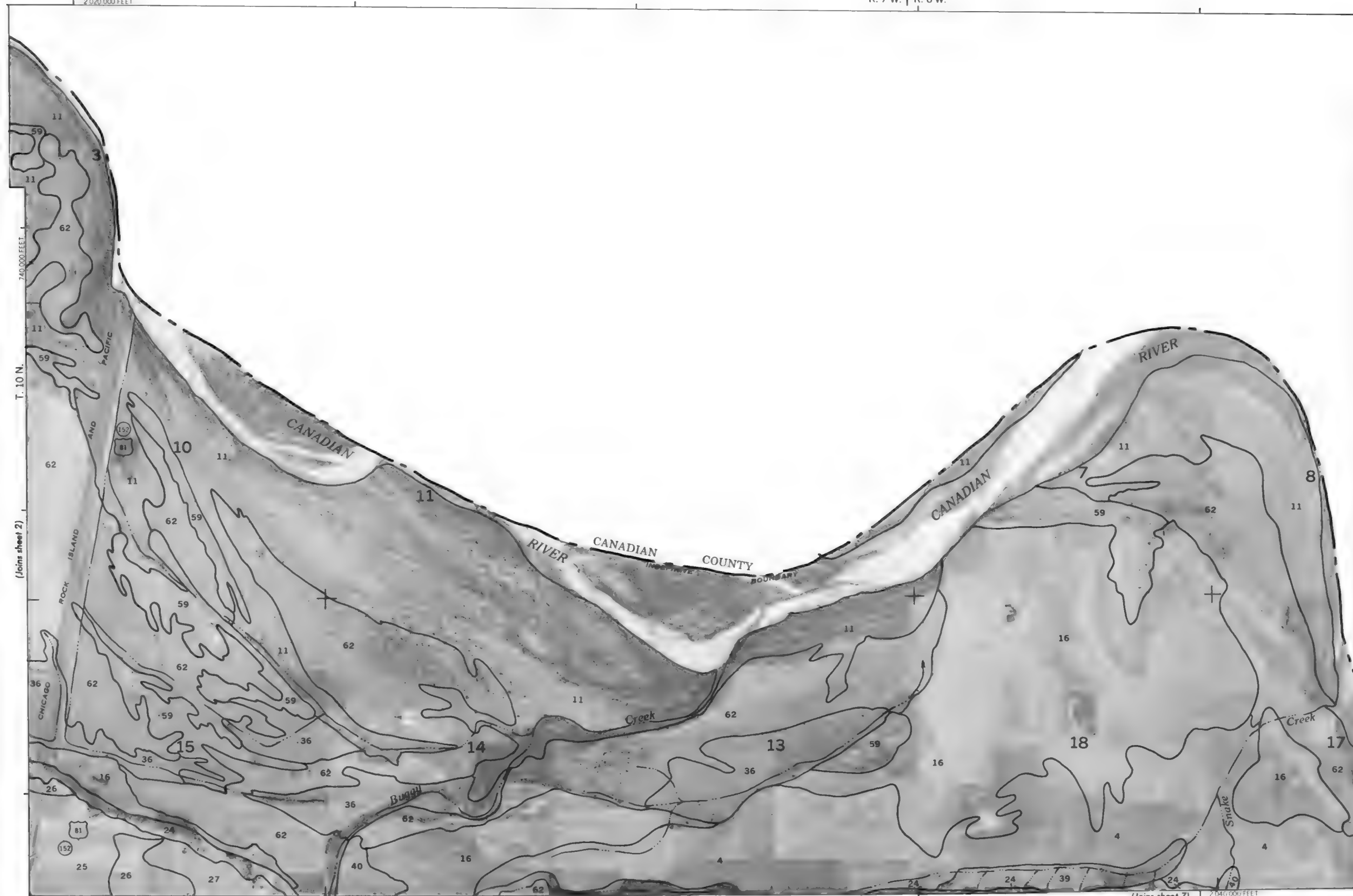
(Joins sheet 35)

(Joins sheet 30)



2020,000 FEET

R. 7 W. | R. 6 W.



(Joins sheet 2)

(Joins sheet 4)

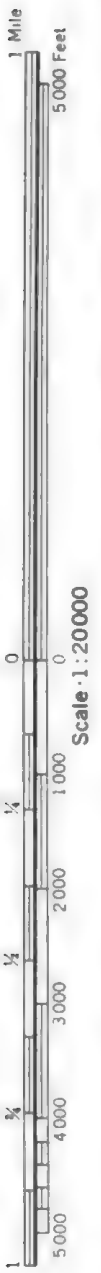
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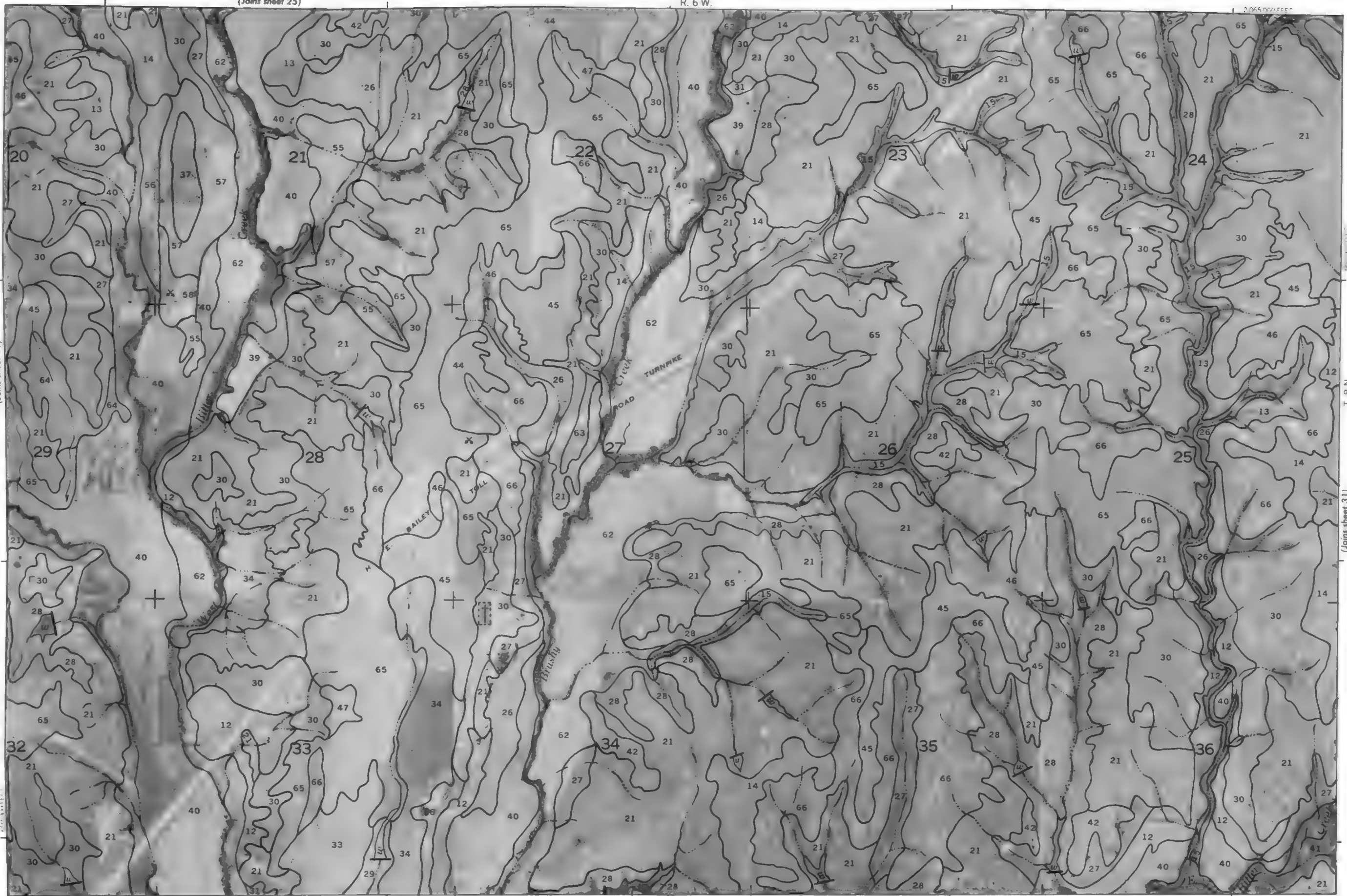
R. 6 W.

2,065,000 FEET



Scale 1:20,000

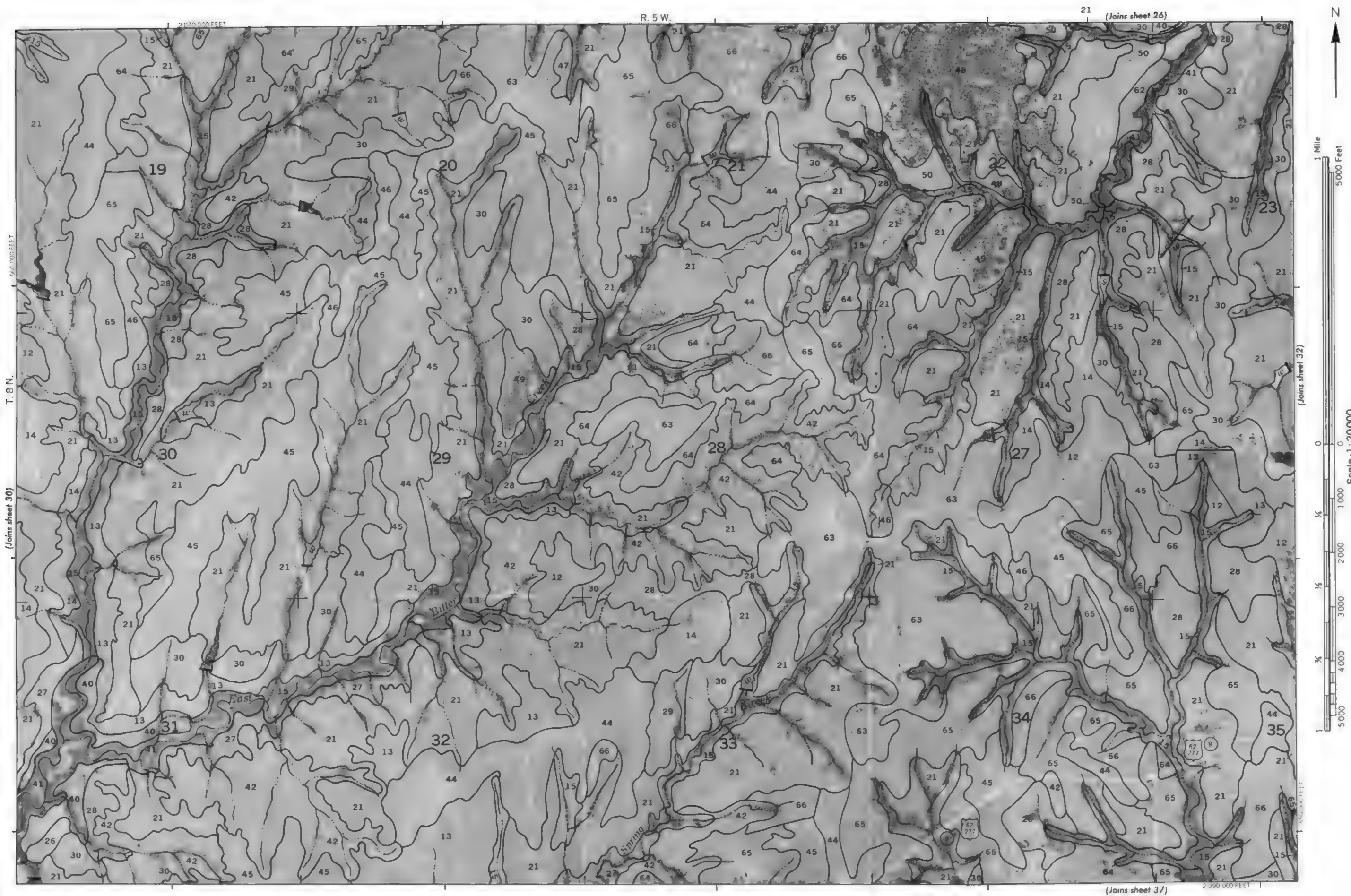
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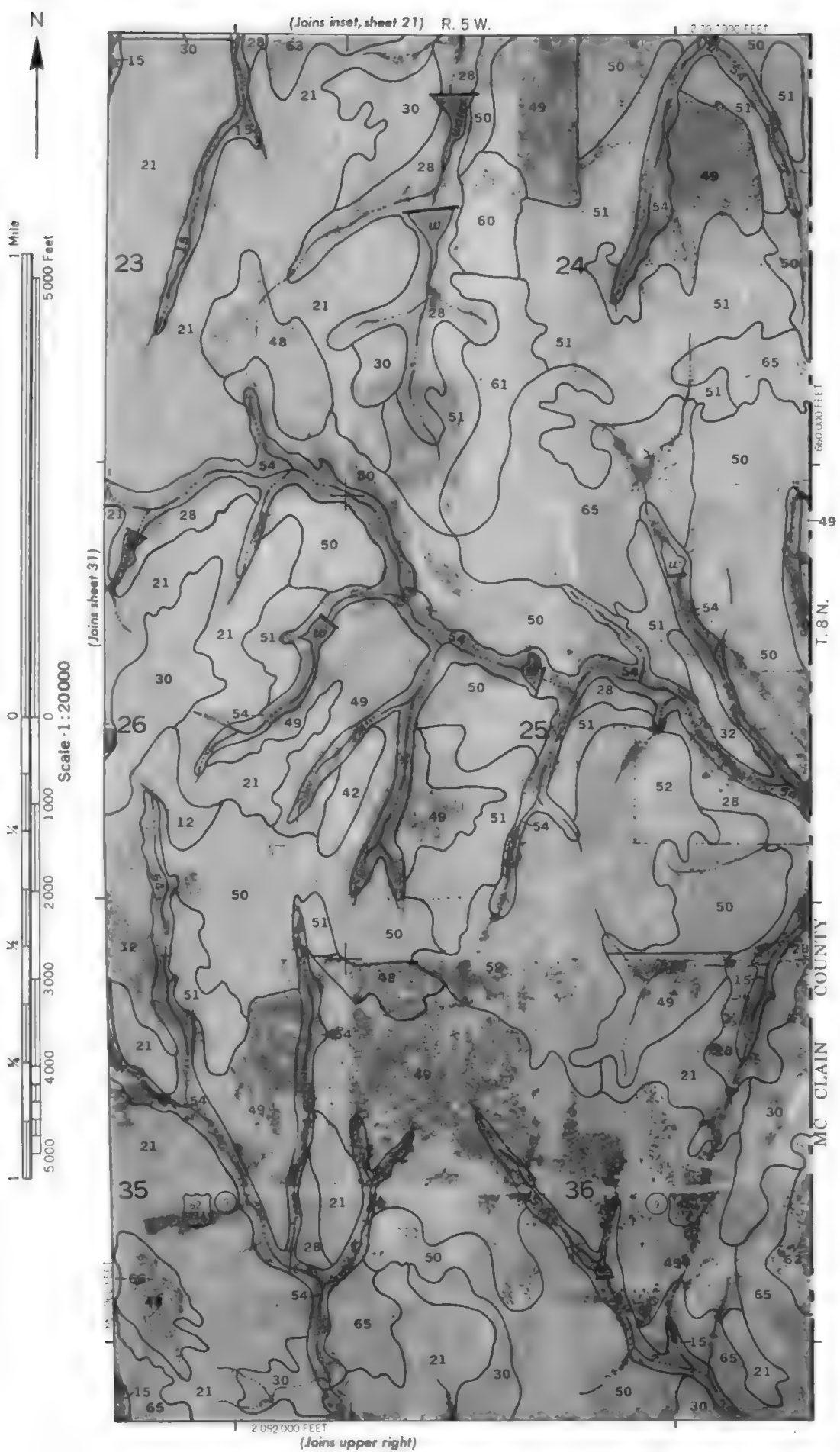


(Joins sheet 31)
T. 8 N.

(Joins sheet 36)

28

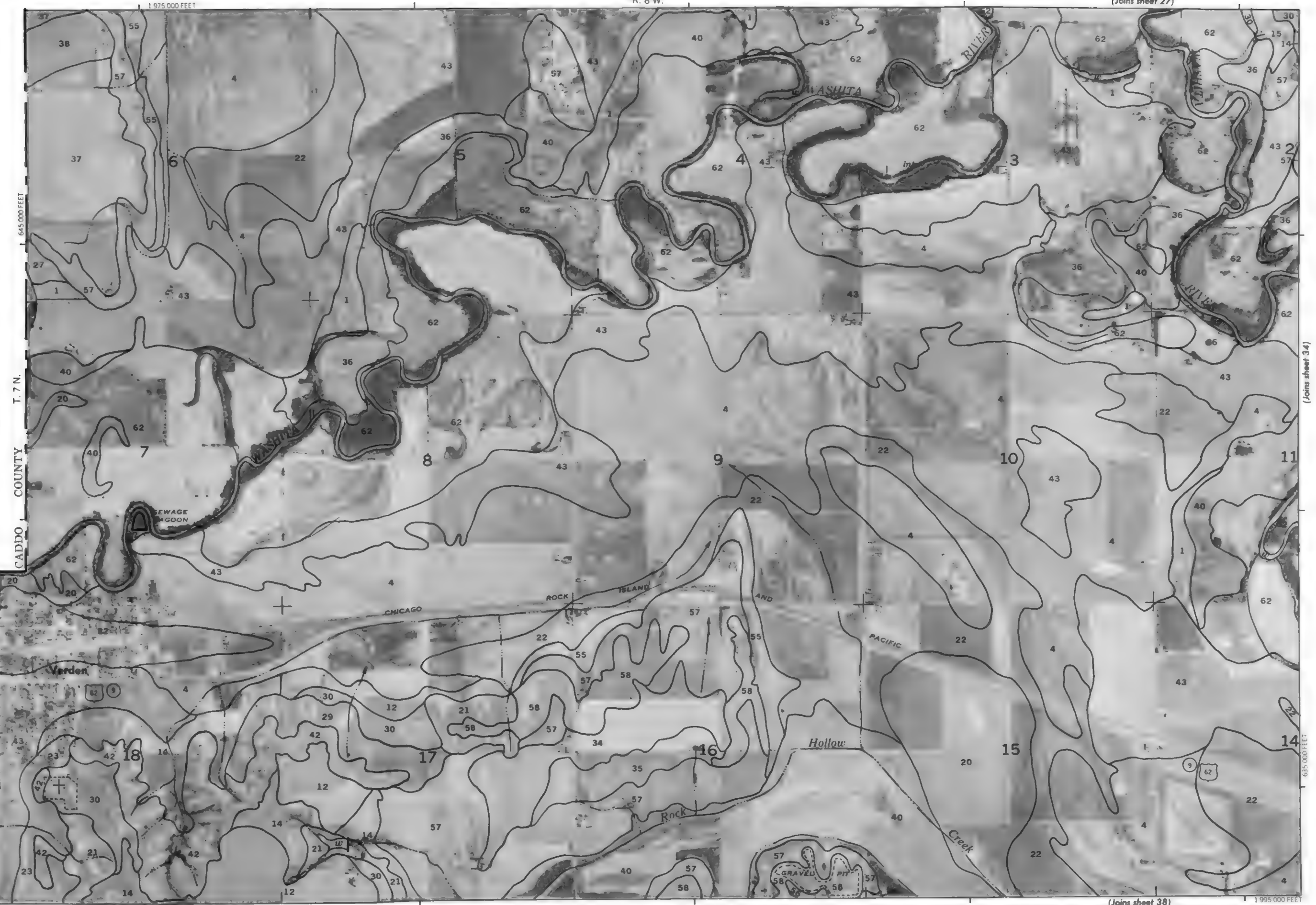




1 975 000 FEET

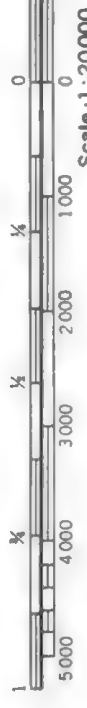
R. 8 W.

(Joins sheet 27)



1 Mile
5000 Feet

(Joins sheet 34)



635 000 FEET

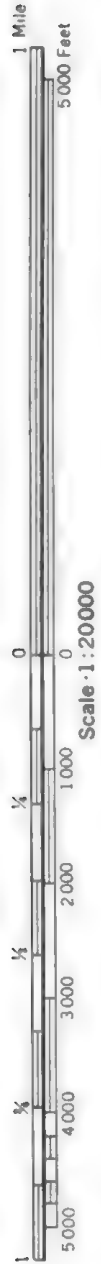
(Joins sheet 38)

1 995 000 FEET

(27) (Joins sheet 28)

R. 8 W. | R. 7 W.

2 015 000 FEET

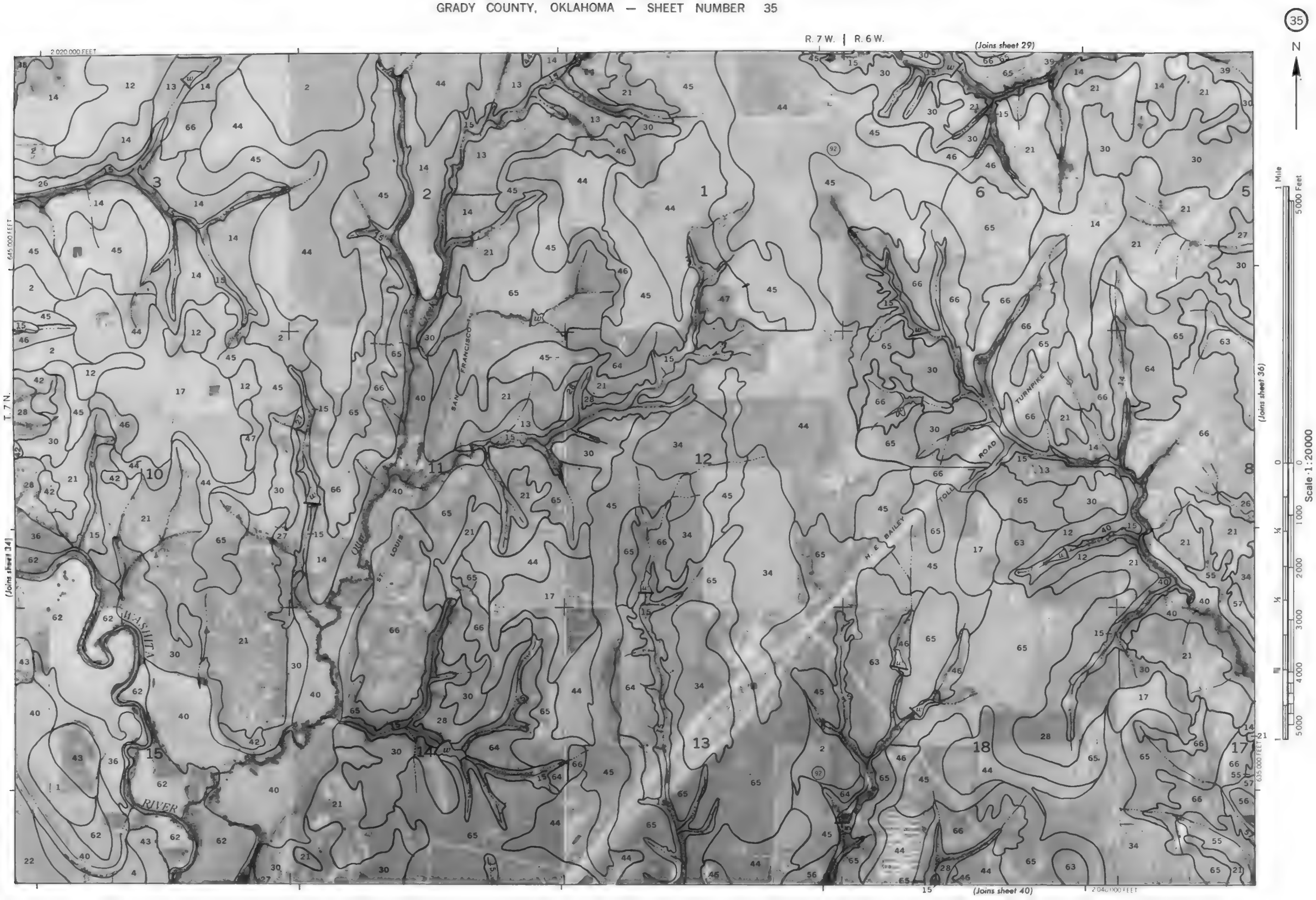


(Joins sheet 33)



(Joins sheet 35)

(Joins sheet 39)

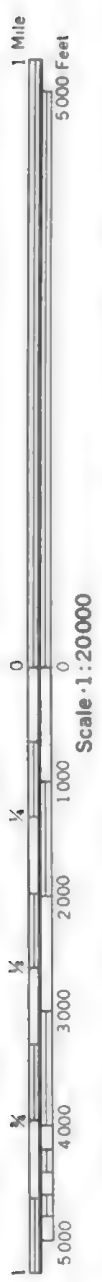




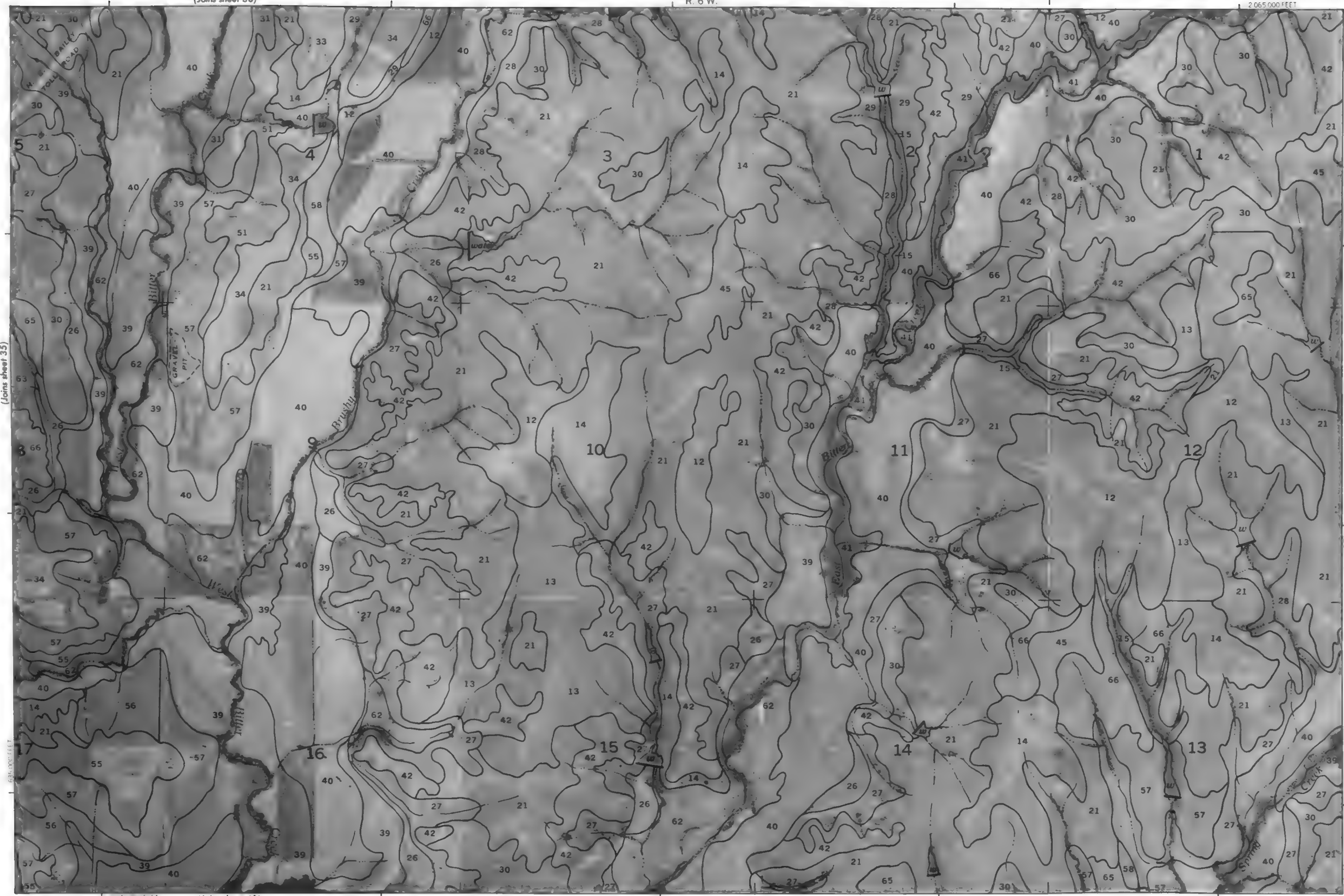
(Joins sheet 30)

R. 6 W.

2 065 000 FEET



(Joins sheet 35)



2 065 000 FEET

T. 7 N.

(Joins sheet 37)

(Joins sheet 41)

R. 5 W.

(Joins sheet 31)

2 070 000 FEET

2 090 000 FEET



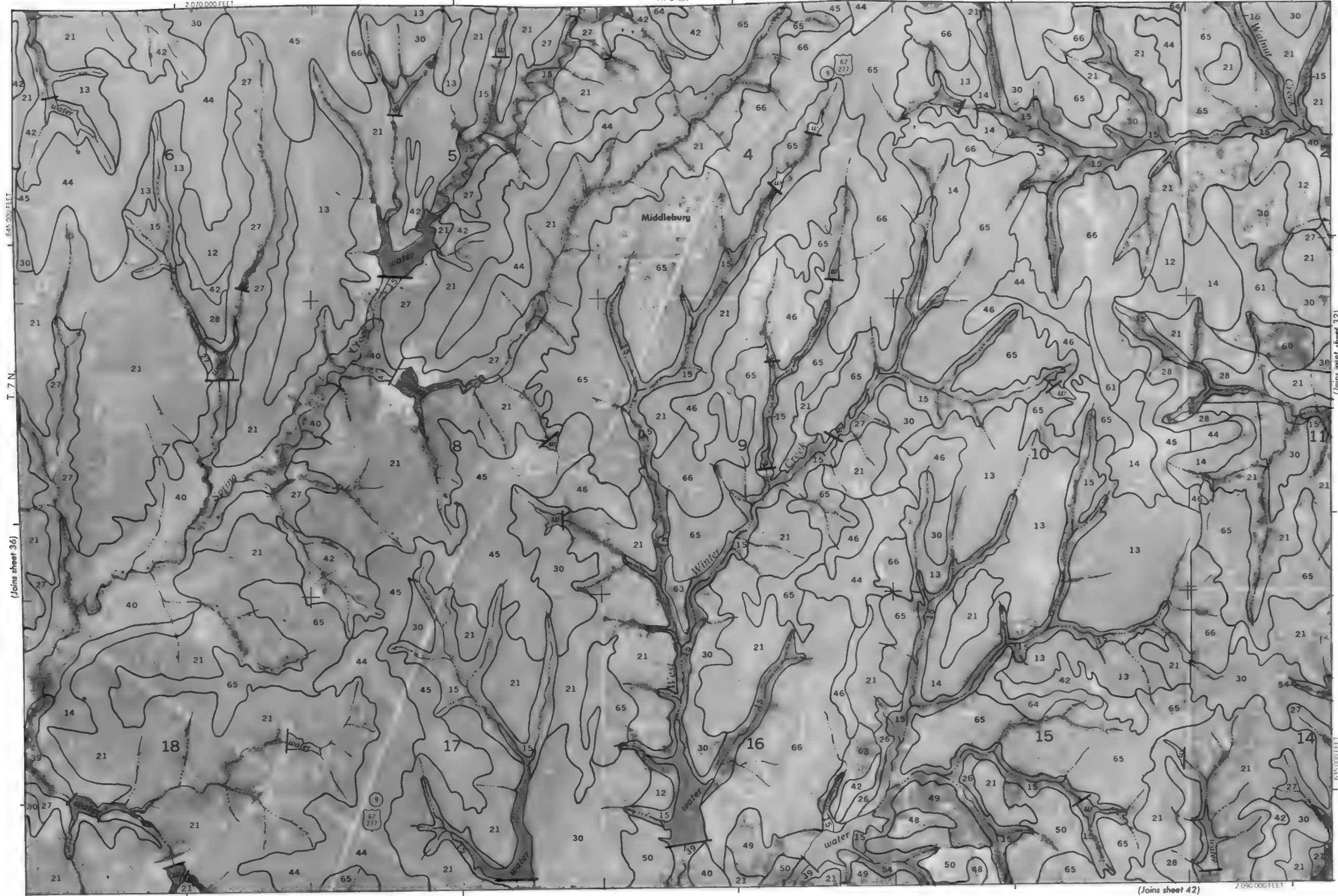
1 Mile
5 000 Feet

Scale 1:20 000

(Joins sheet 32)

(Joins sheet 36)

(Joins sheet 42)





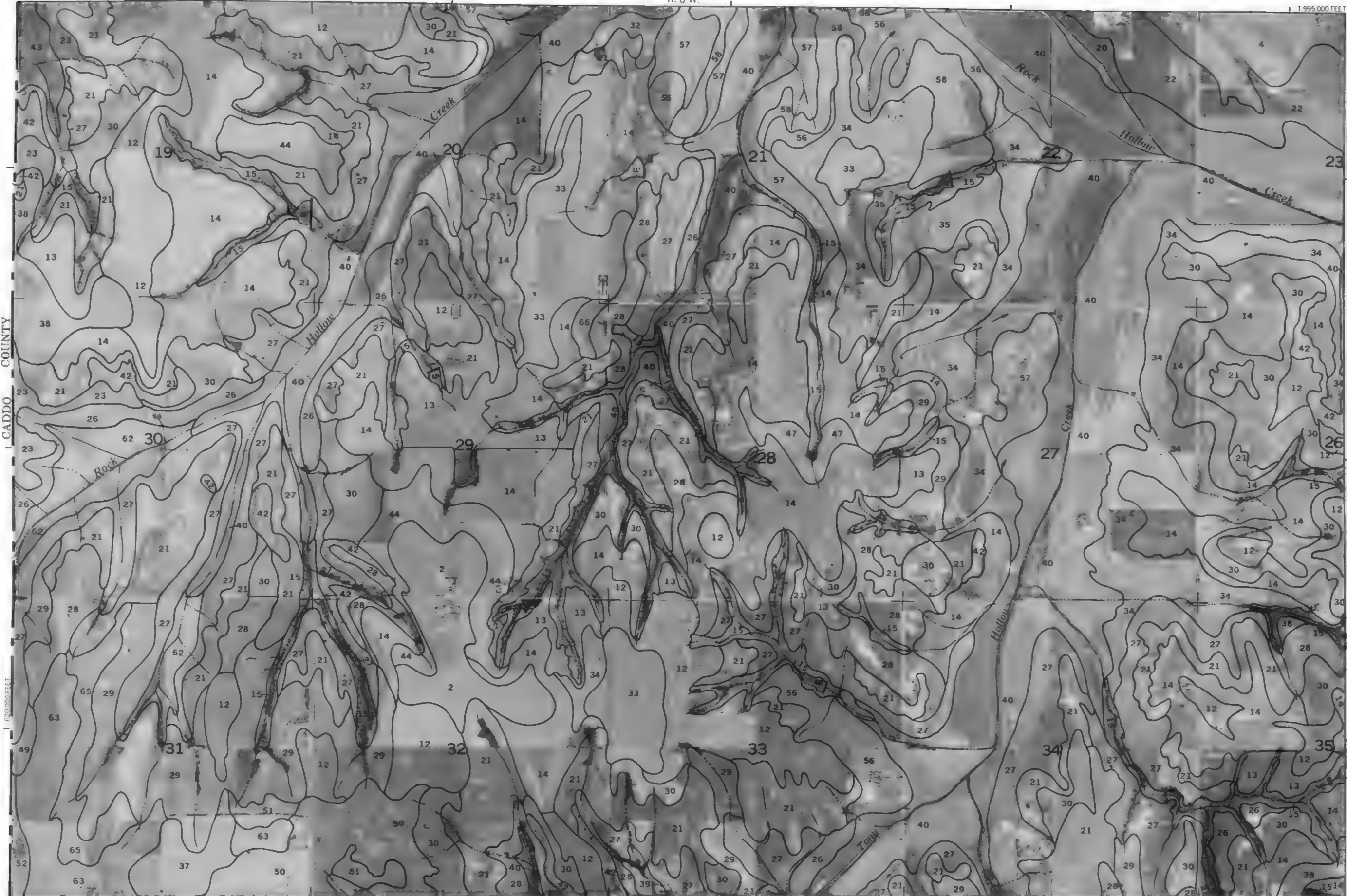
(Joins sheet 33)

R. 8 W.

1 995 000 FEET



CADDO COUNTY

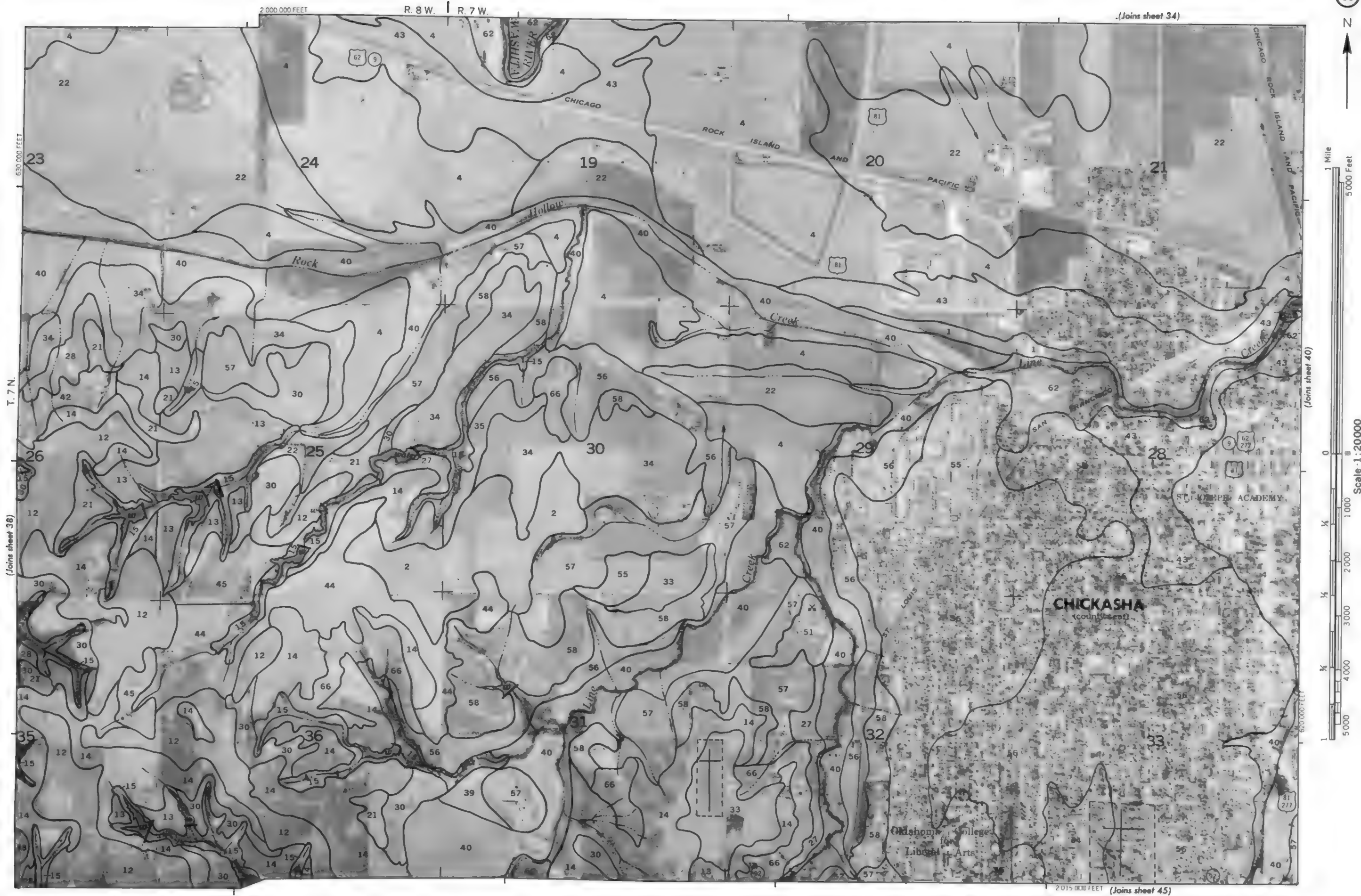


1 975 000 FEET (Joins sheet 44)

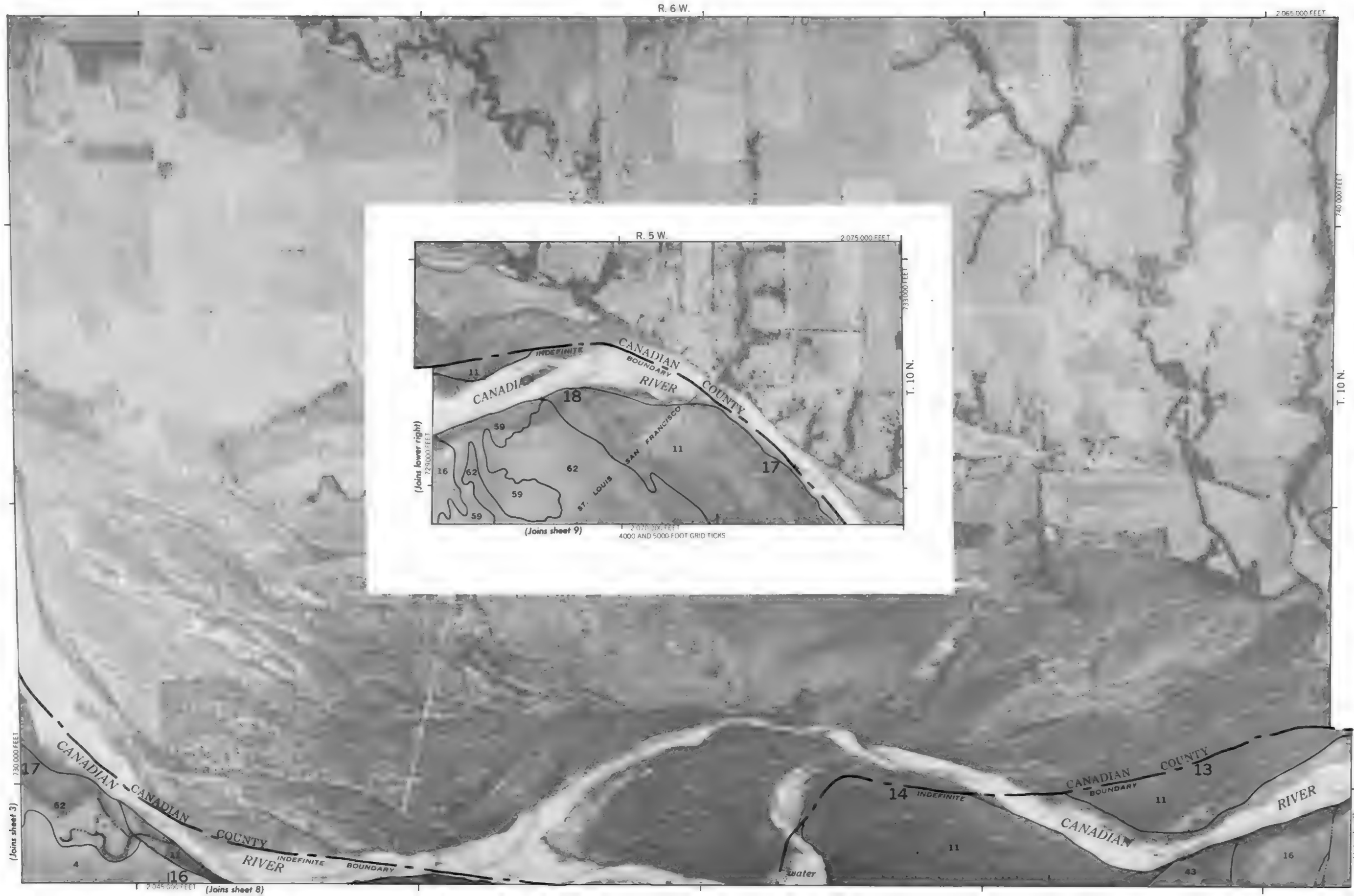
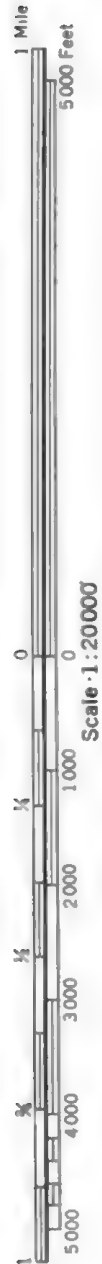
630 000 FEET

T. 7 N.

(Joins sheet 39)



4

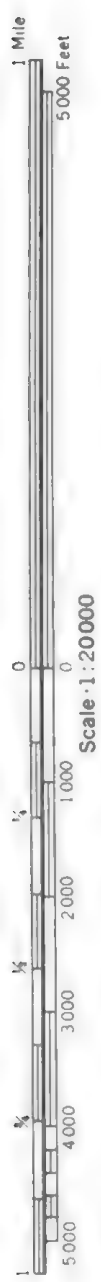


R. 7 W. | R. 6 W.

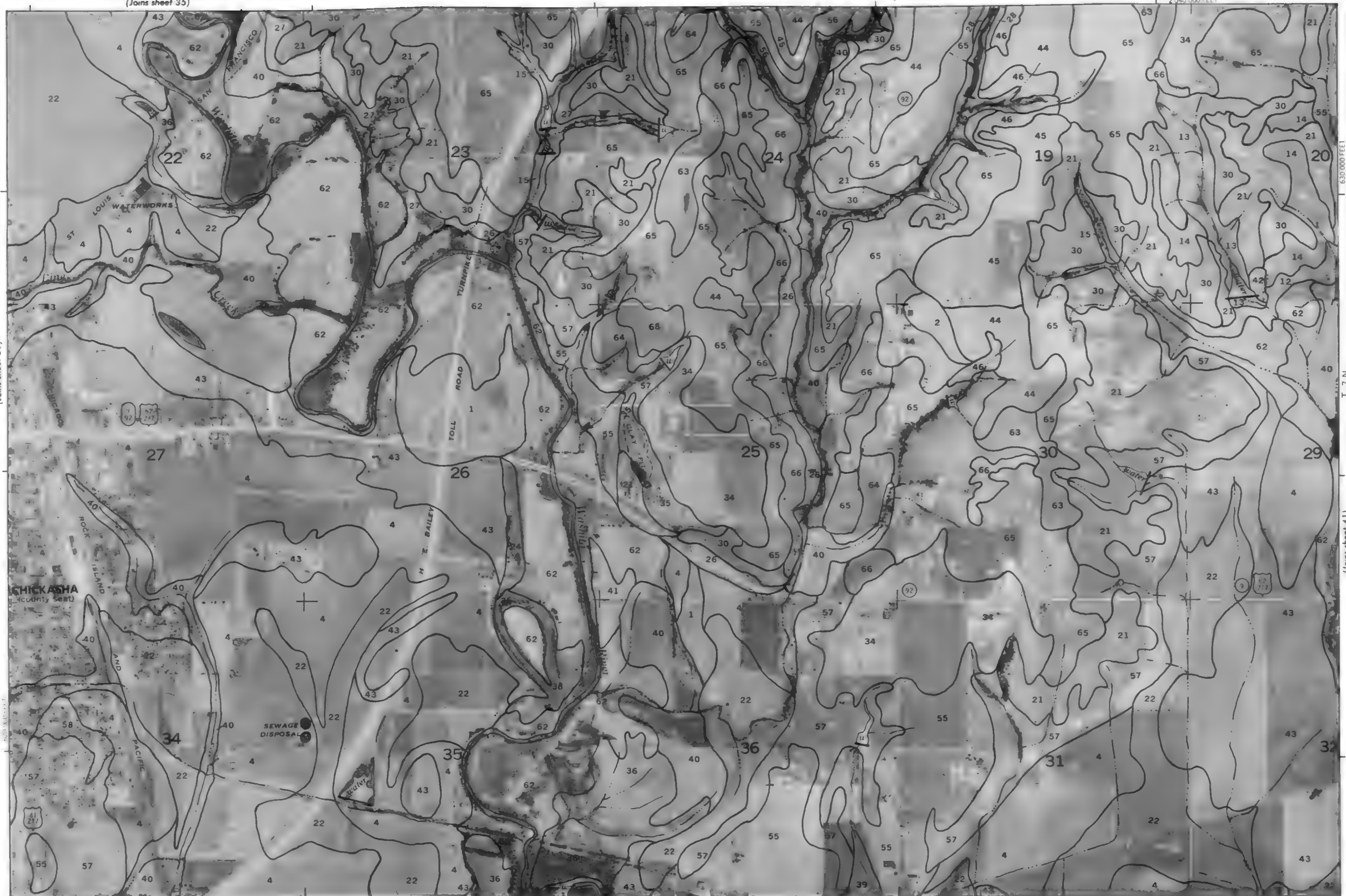
2 040 000 FEET



(Joins sheet 35)



(Joins sheet 39)

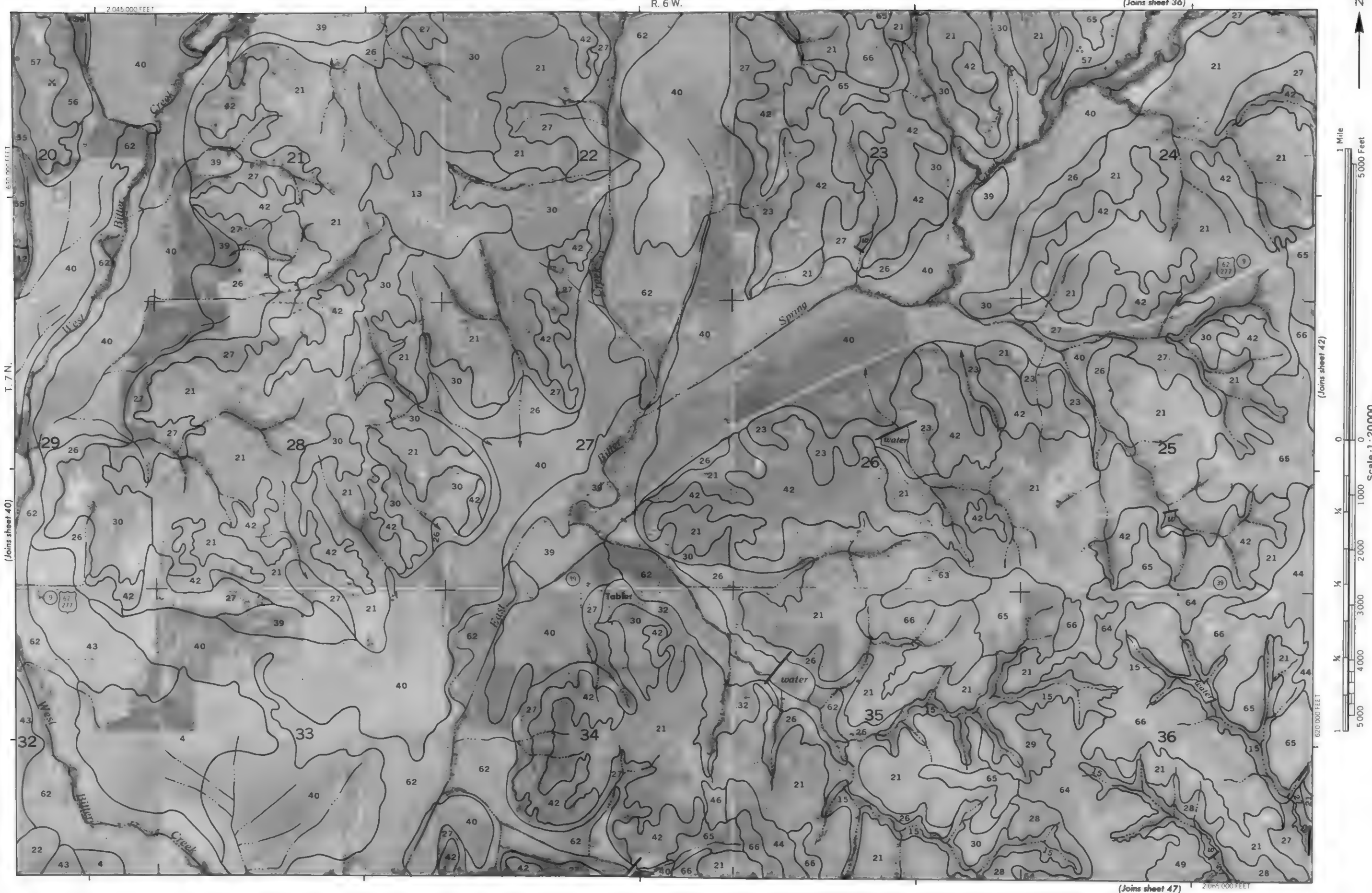


630 000 FEET

T. 7 N.

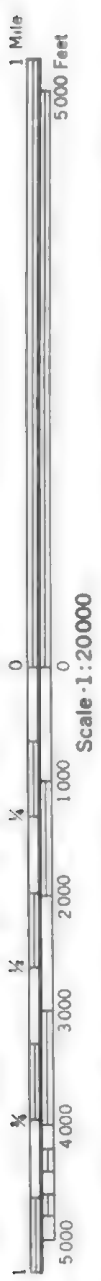
(Joins sheet 41)

(Joins sheet 46)

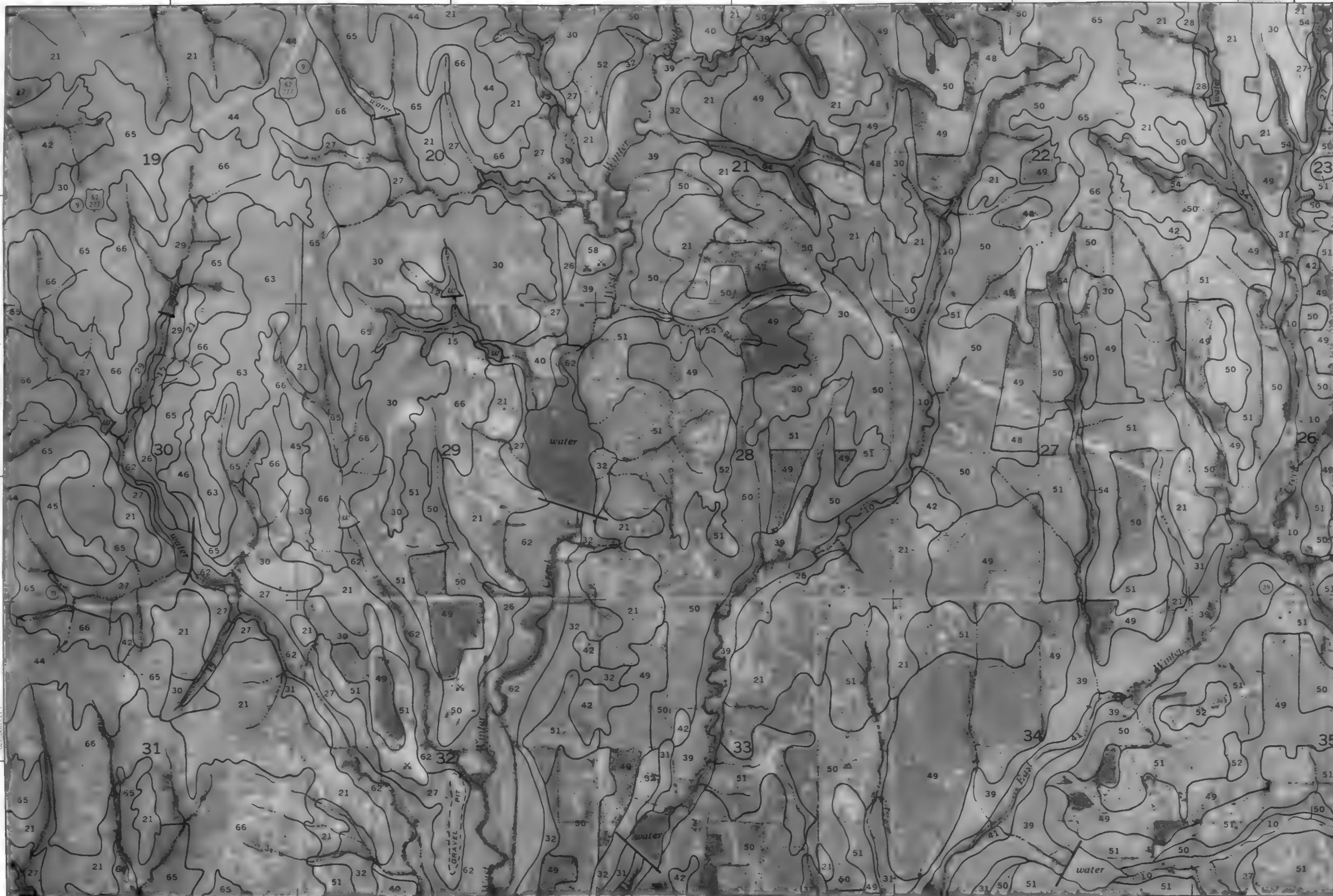


R. 5 W.

(Joins sheet 37)

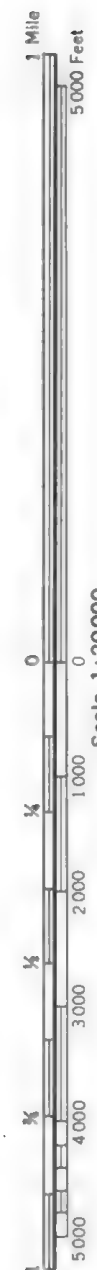
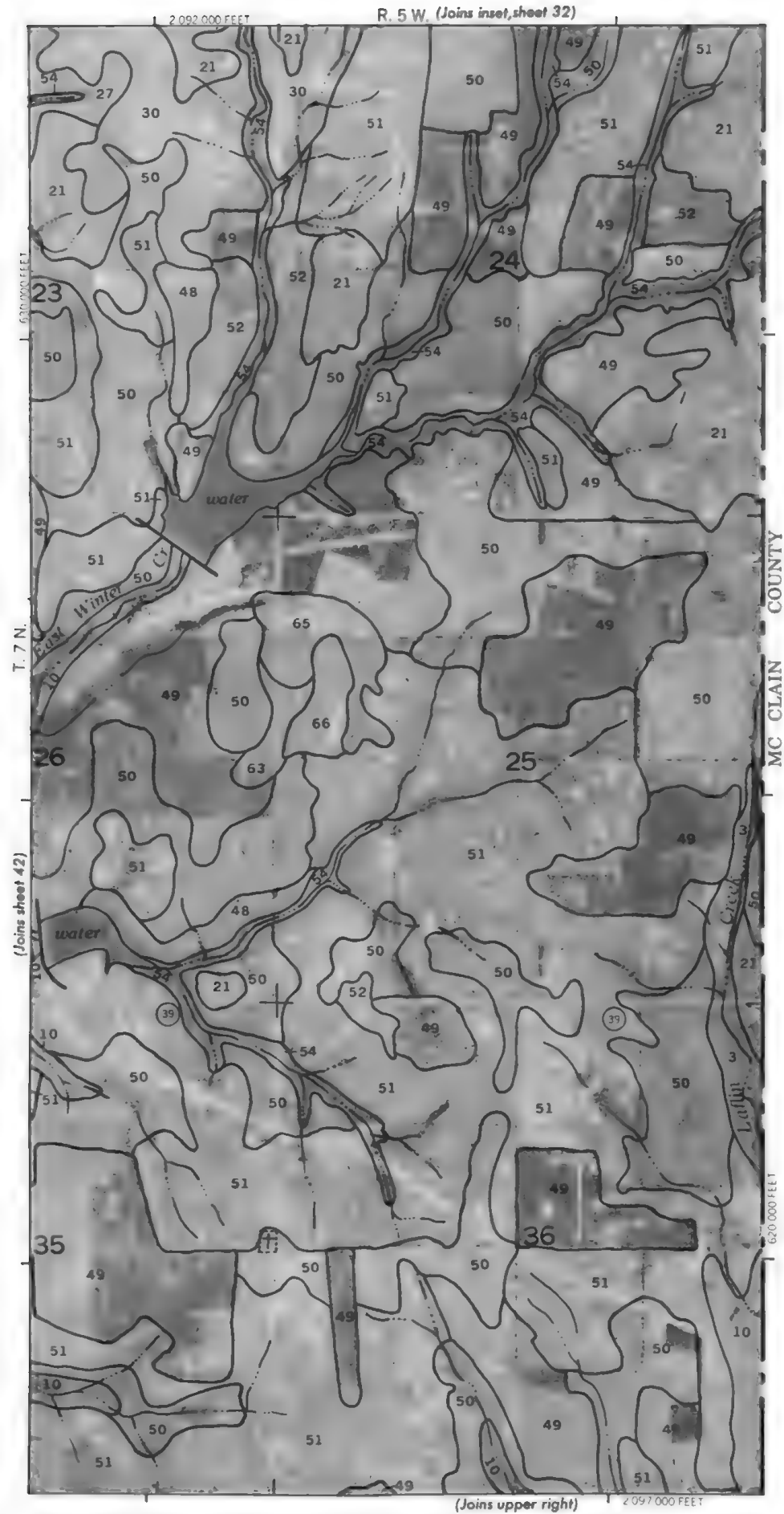


(Joins sheet 41)



(Joins sheet 43)

(Joins sheet 48)





(Joins sheet 39)

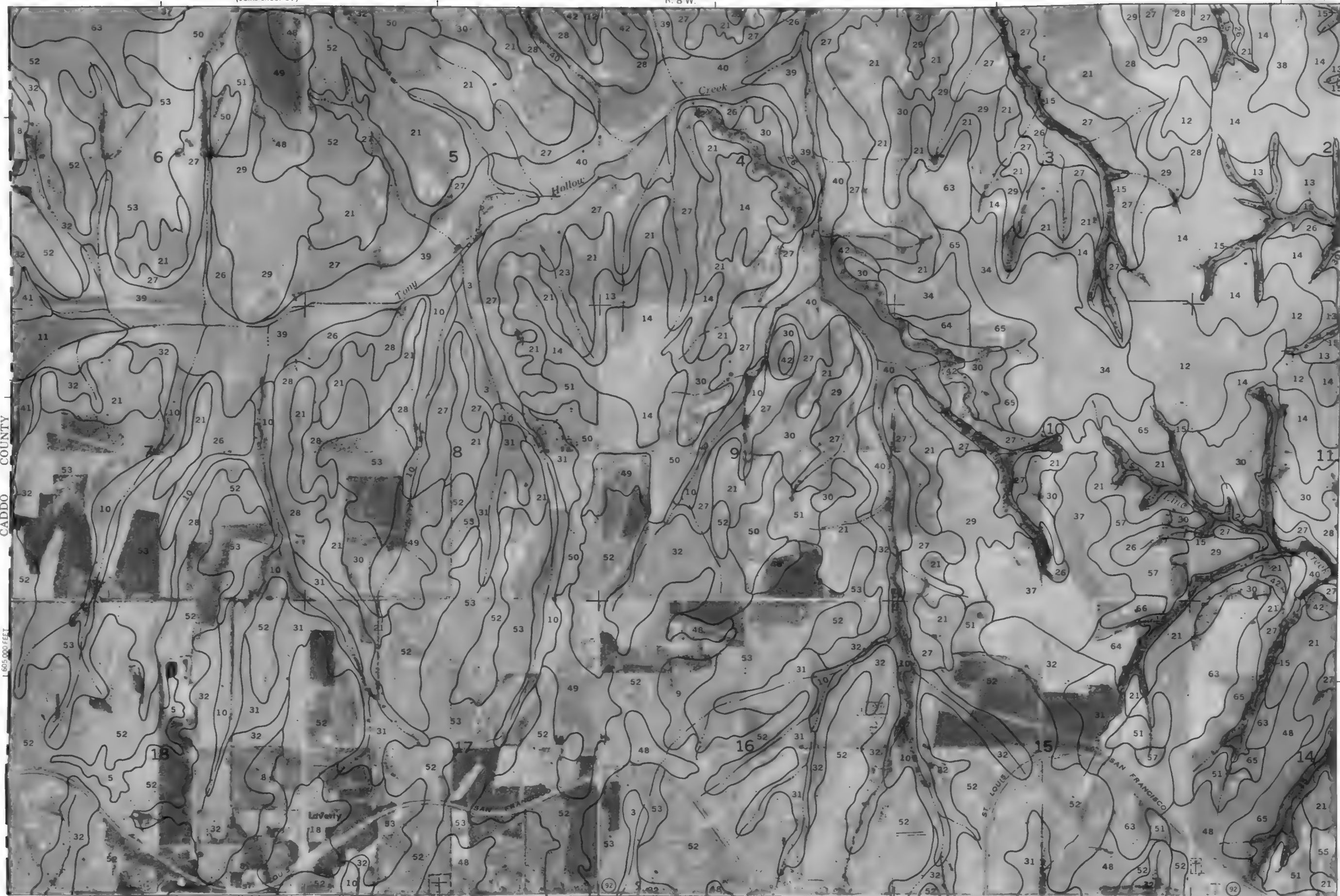
R. 8 W.



Scale 1:20000

CADDO COUNTY

1605000 FEET



T. 6 N.

(Joins sheet 45)

1975 000 FEET

(Joins sheet 49)

2 000 000 FEET

R. 8 W. | R. 7 W.

(Joins sheet 39)



1 Mile

5000 Feet

(Joins sheet 46)

0

0

1000

2000

3000

4000

5000

Scale 1:20000

605 000 FEET

1

1/4

1/2

3/4

1

1 1/4

1 1/2

1 3/4

2

2 1/4

2 1/2

2 3/4

3

3 1/4

3 1/2

3 3/4

4

4 1/4

4 1/2

4 3/4

5

5 1/4

5 1/2

5 3/4

6

CHICKASHA
county seat

TURNPIKE

ROAD

TOLL

BAILEY

SAN FRANCISCO

LOUIS

Creek

Line

Norge

615 000 FEET

T. 6 N.

(Joins sheet 44)

2 015 000 FEET

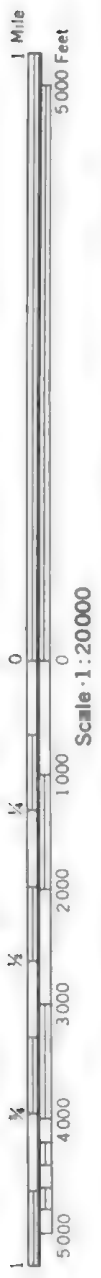
(Joins sheet 50)



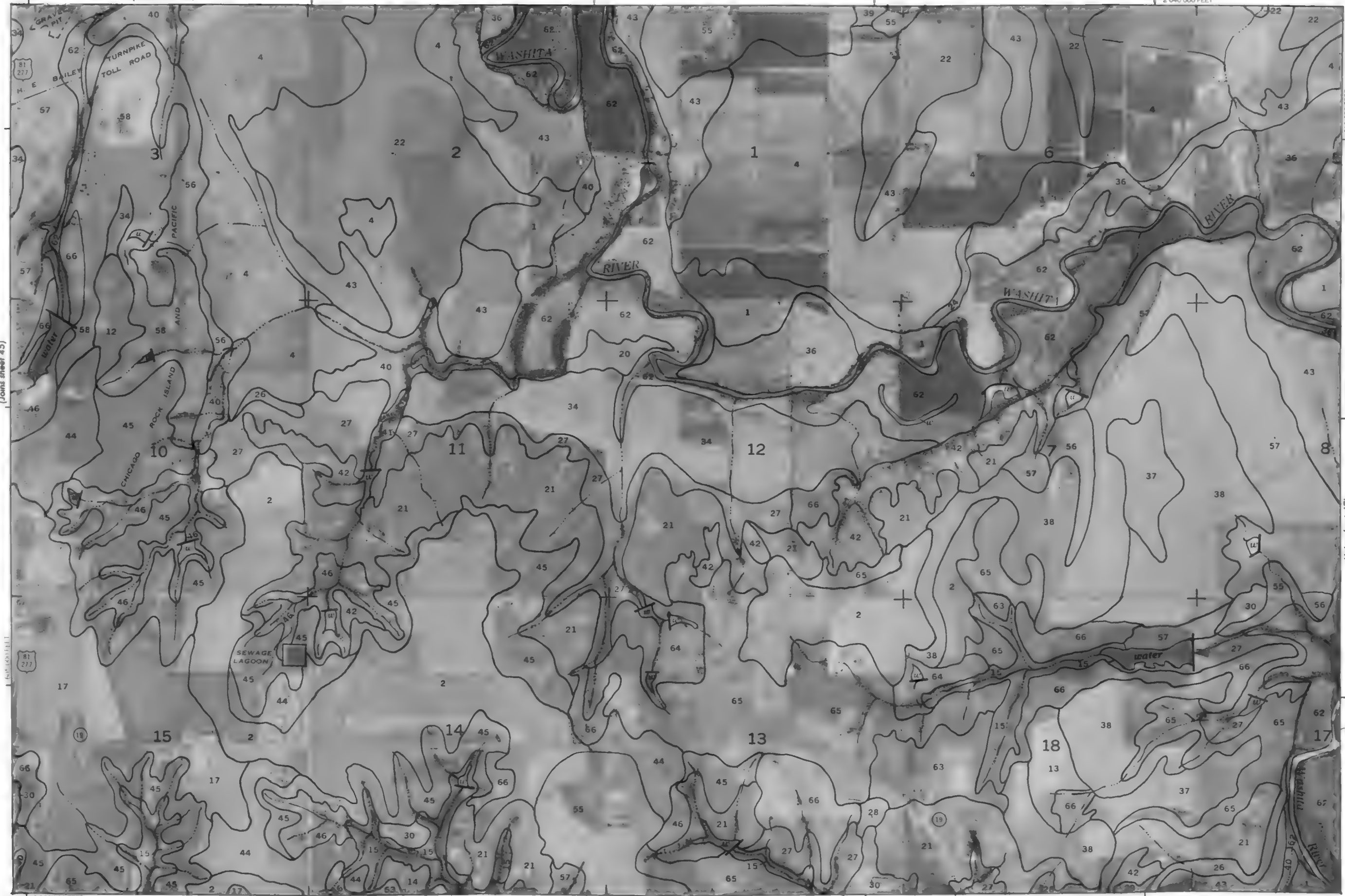
(Joins sheet 40)

R. 7 W. | R. 6 W.

2 040 000 FEET



(Joins sheet 45)



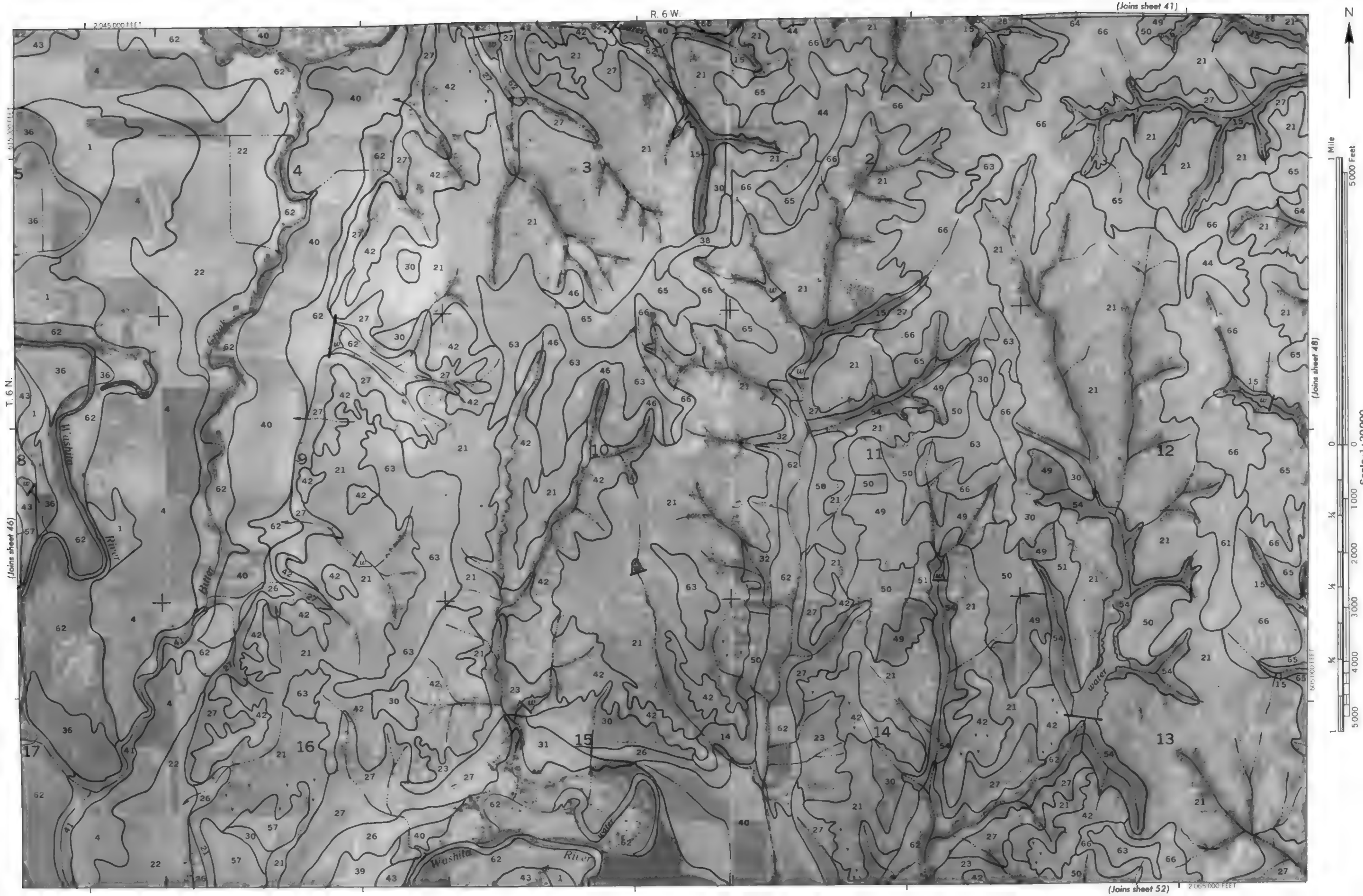
2 020 000 FEET

(Joins sheet 51)

615 000 FEET

T. 6 N.

(Joins sheet 47)





(Joins sheet 42)

R. 5 W.

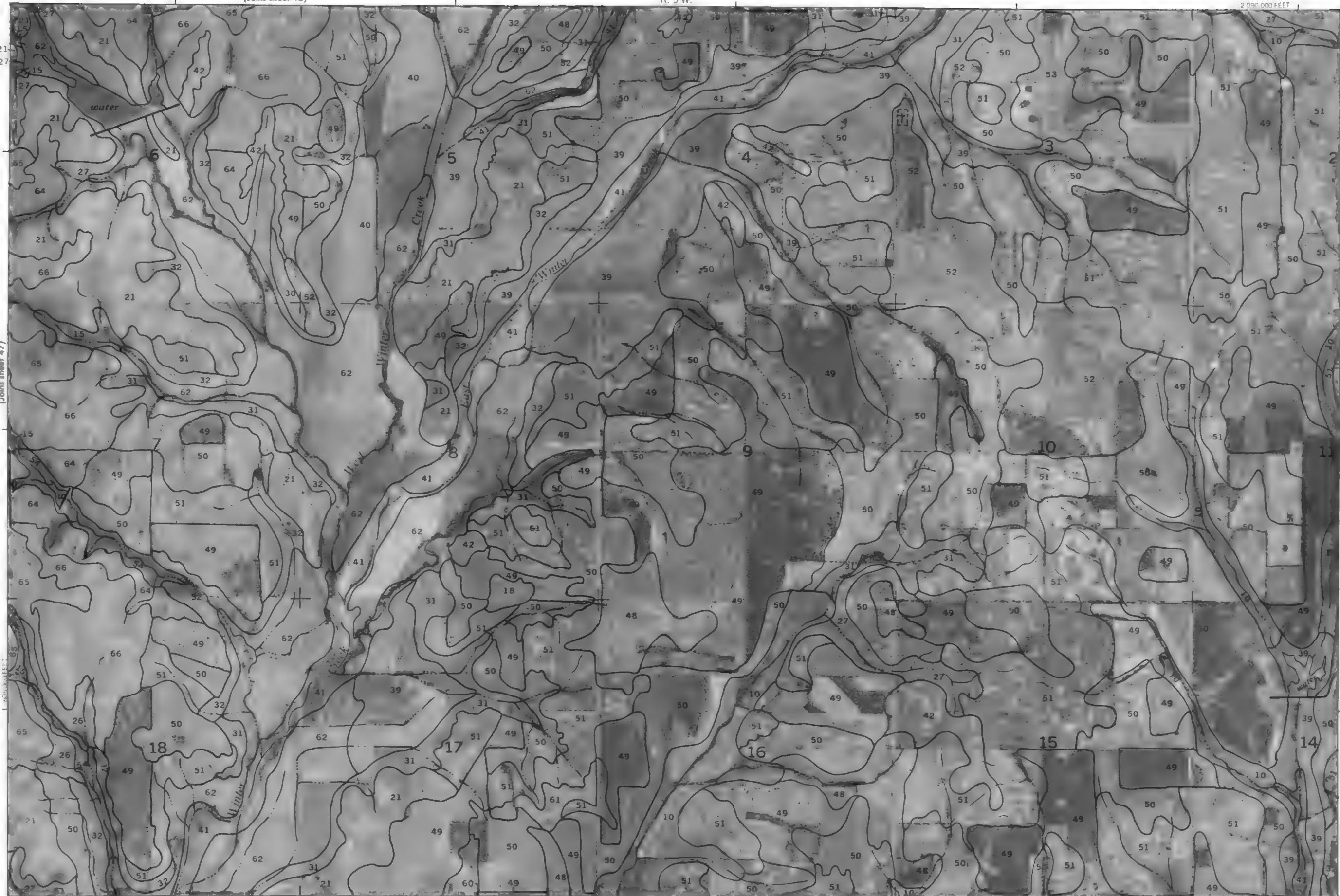
2 090 000 FEET



(Joins sheet 47)

Scale 1:20000

(Joins sheet 43)

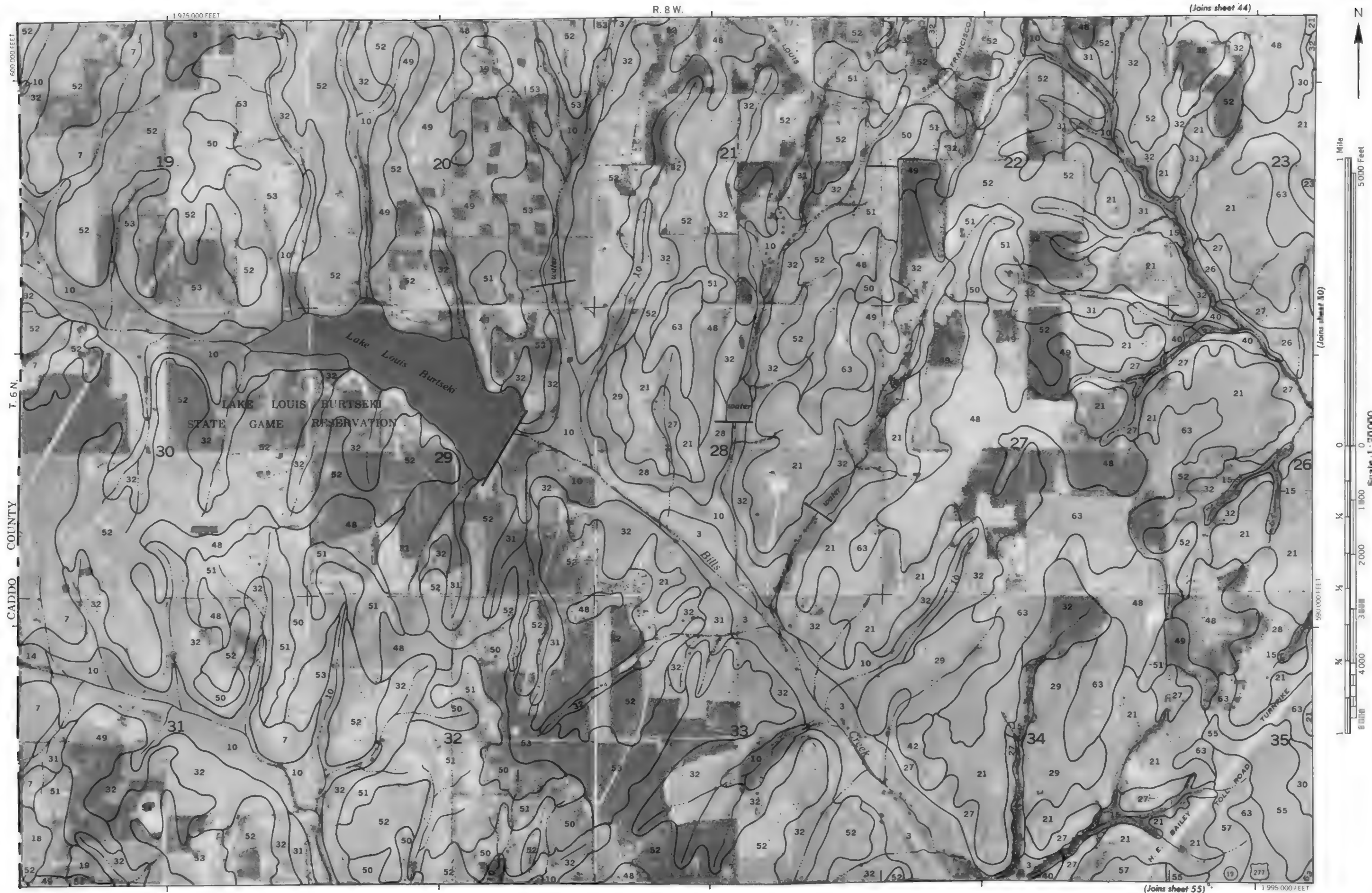


2 070 000 FEET (Joins sheet 53)

615 000 FEET

T. 6 N.

(Joins sheet 43)



(Joins sheet 1)



(Joins sheet 6)

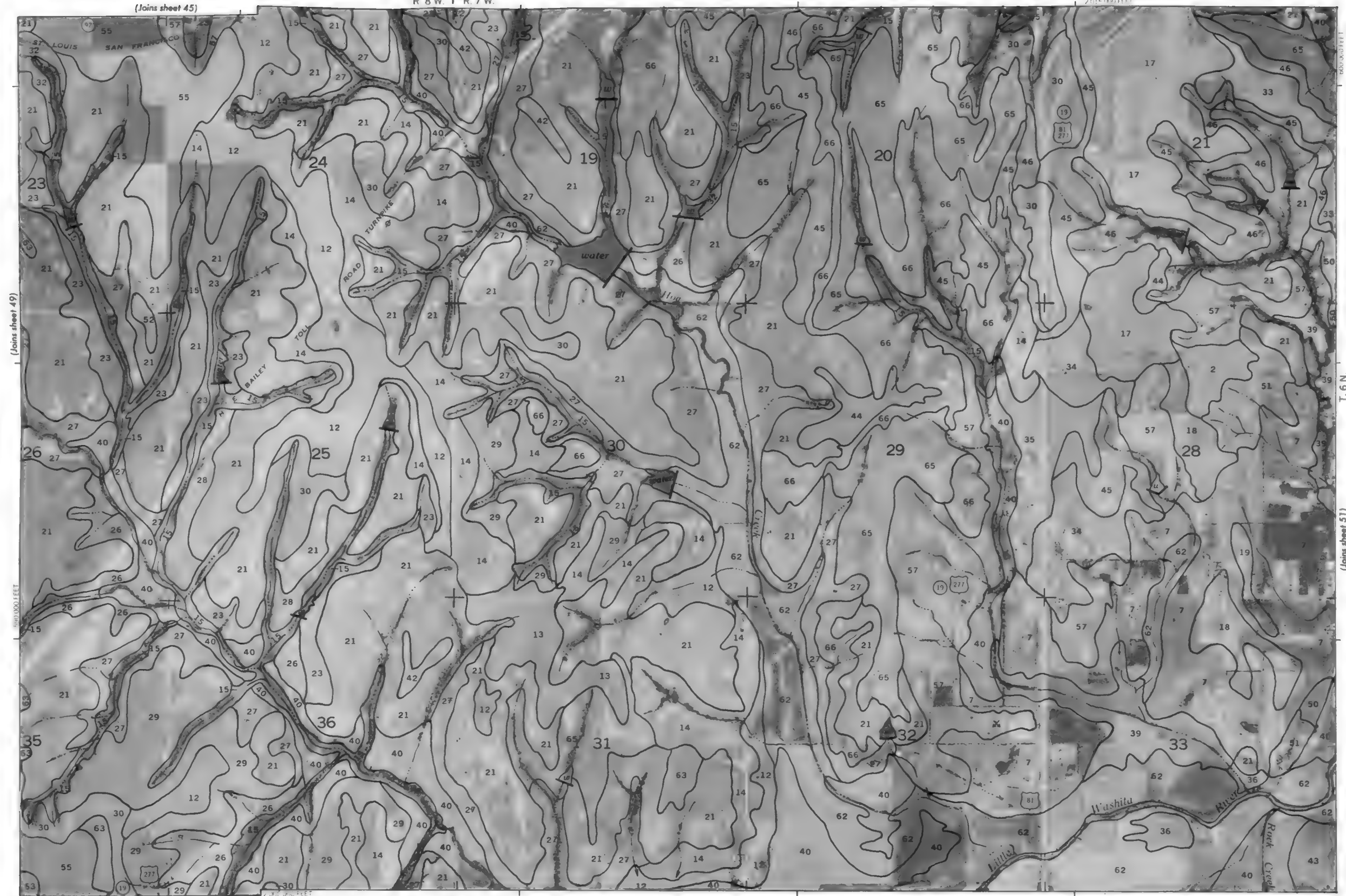
0
Scale: 1:20000



Scale 1:20000

R 8 W. | R 7 W.

2015 000 FEET



(Joins sheet 45)

(Joins sheet 49)

(Joins sheet 56)

(Joins sheet 51)

T. 6 N.

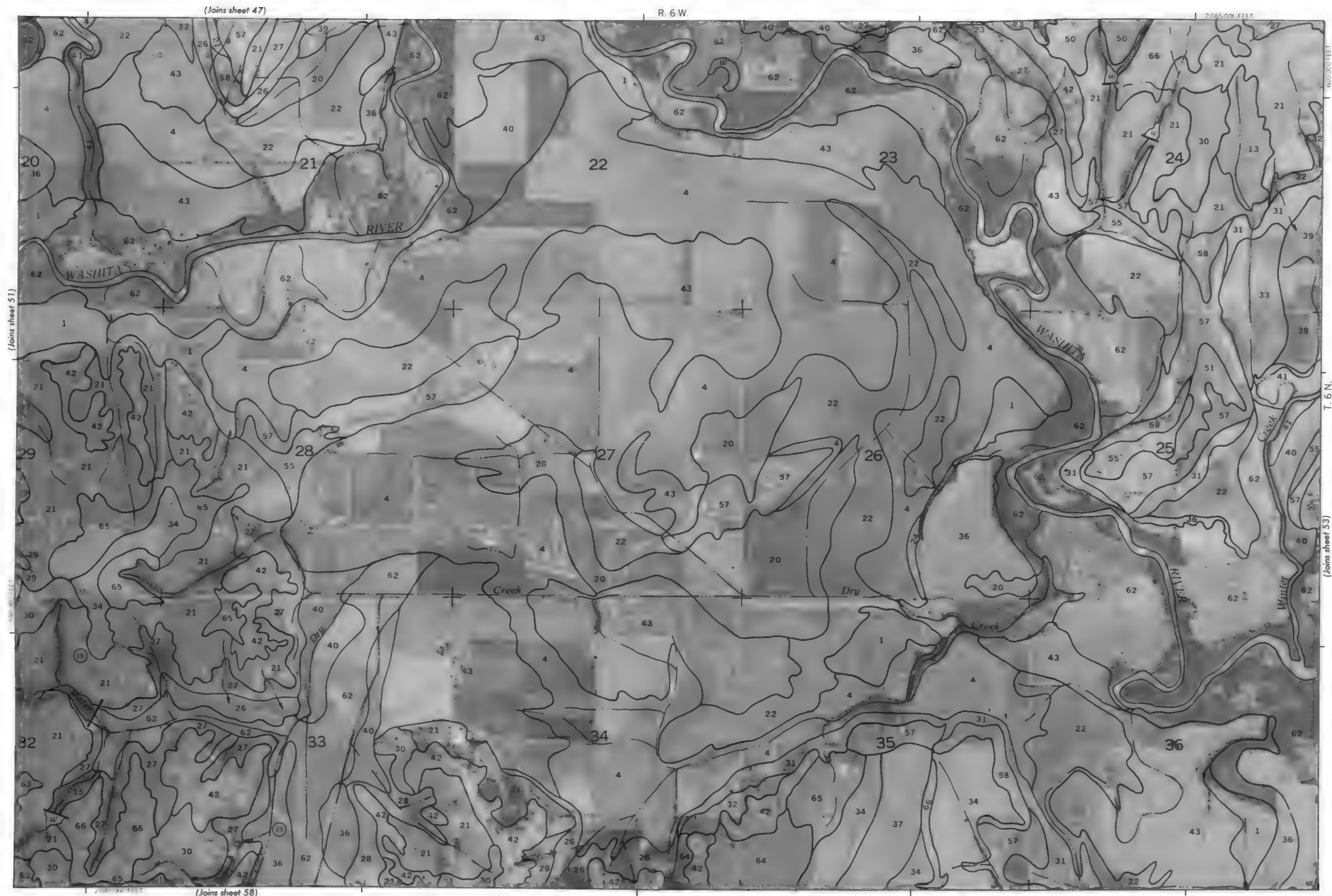




1 Mile
5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000
Feet





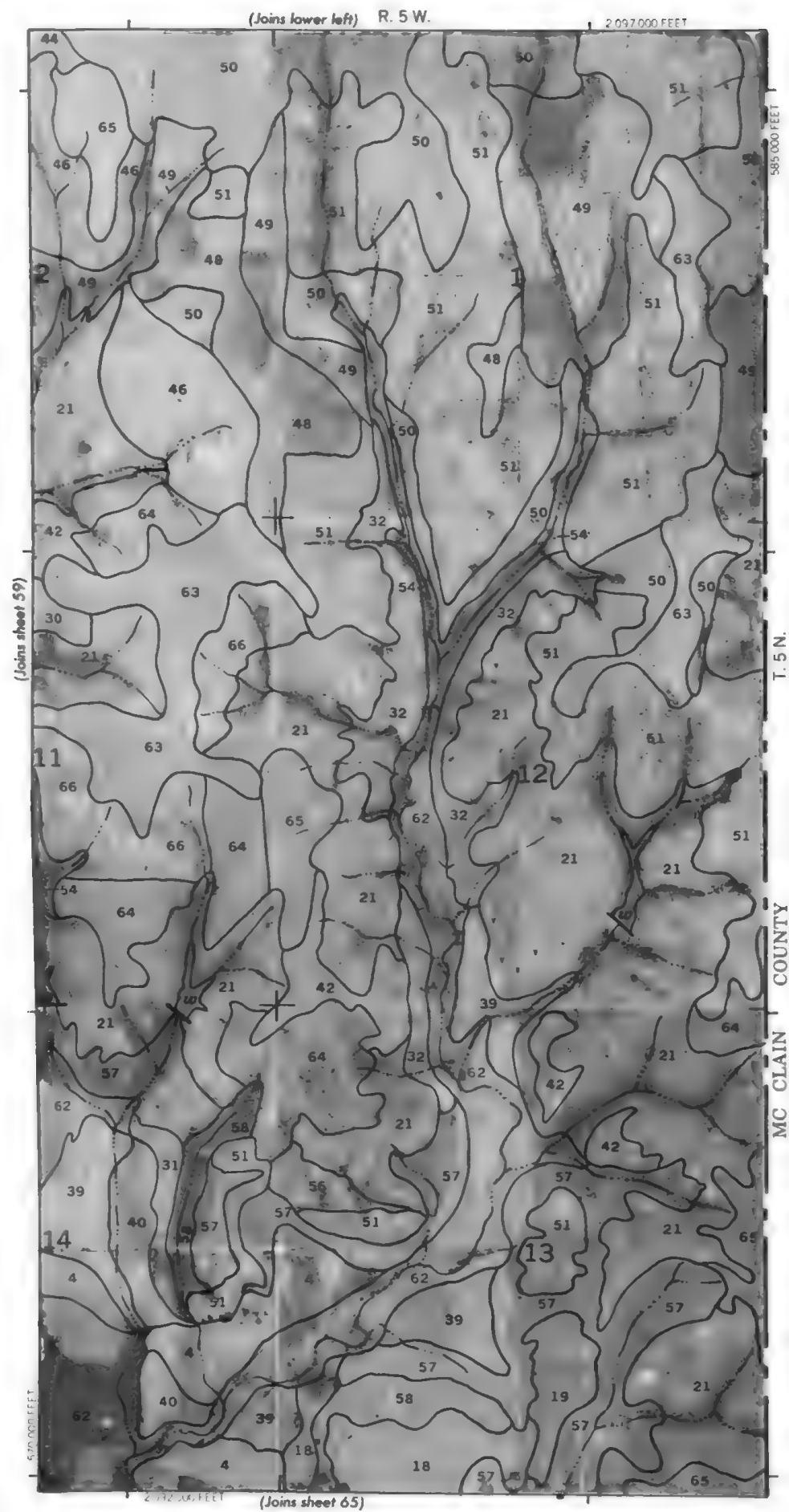
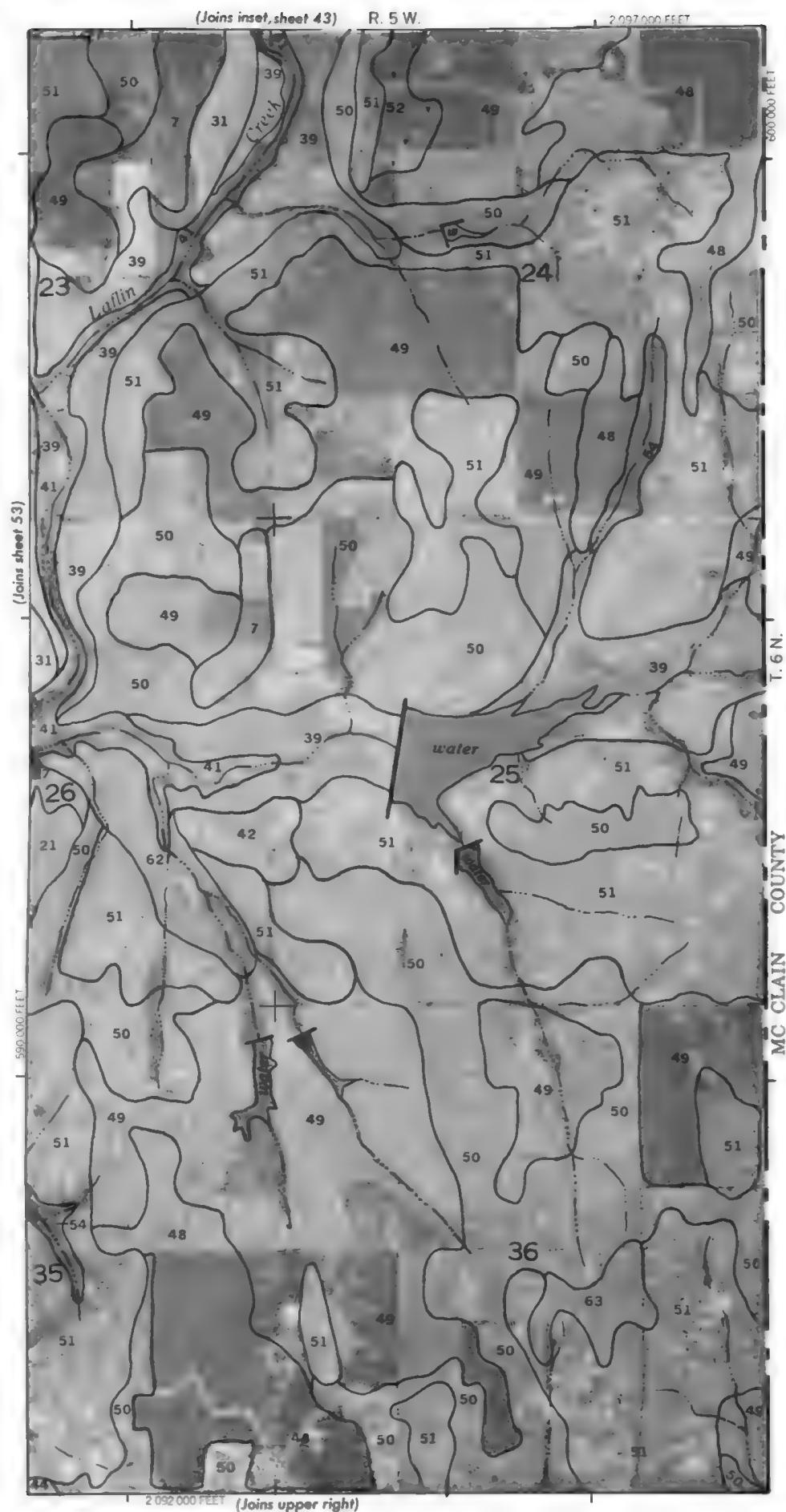
54



1 Mile
5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000
Feet





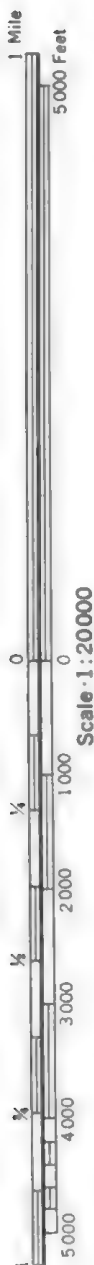
56



(Joins sheet 50)

R. 8 W. | R. 7 W.

2,015,000 FEET

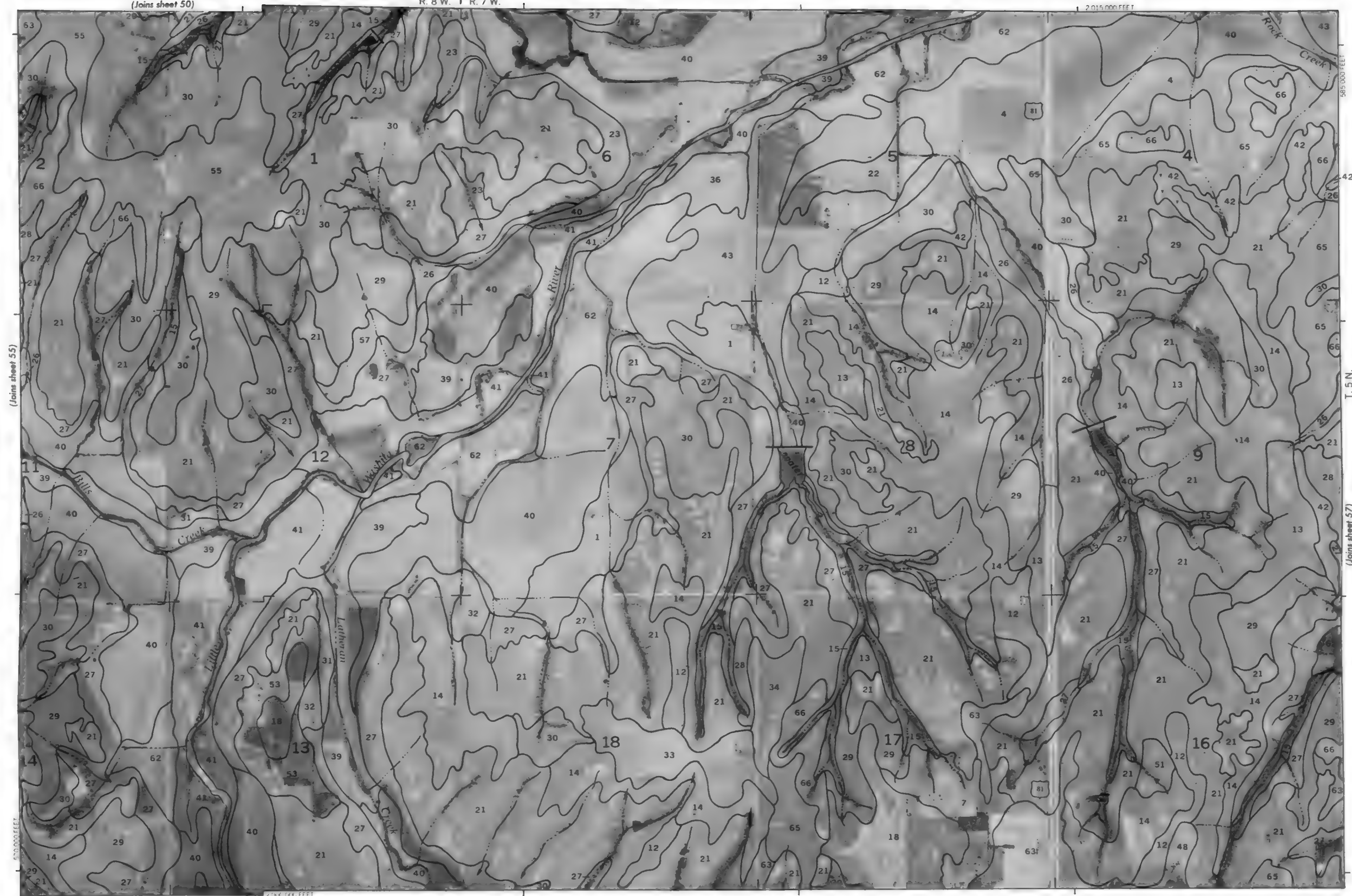


(Joins sheet 55)

Scale 1:20000

T. 5 N.

(Joins sheet 57)



(Joins sheet 61)

2,000,000 FEET

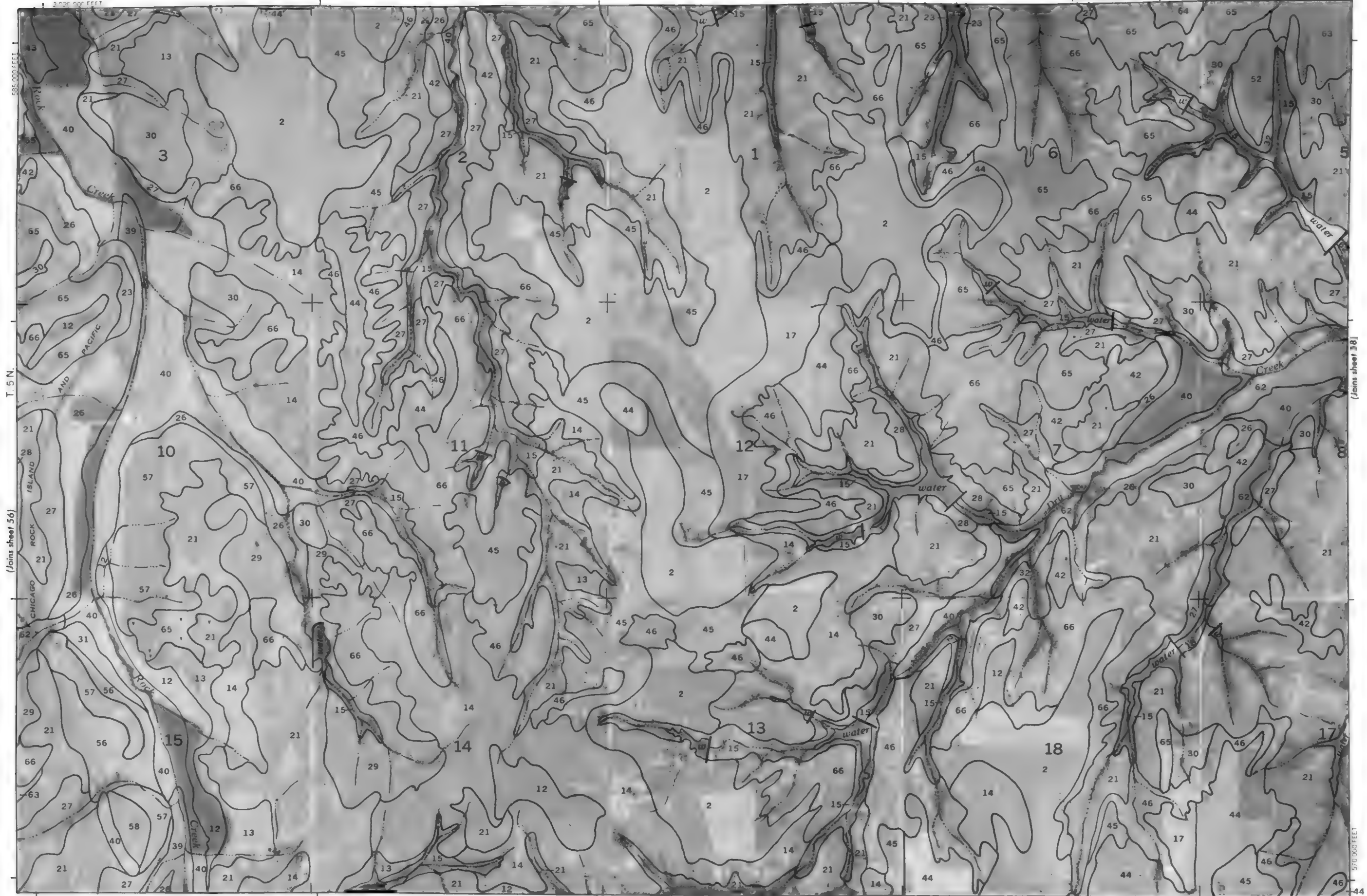
R. 7 W. | R. 6 W.

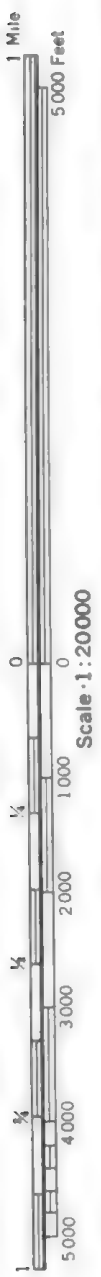
(Joins sheet 51)



1 Mile
5000 Feet

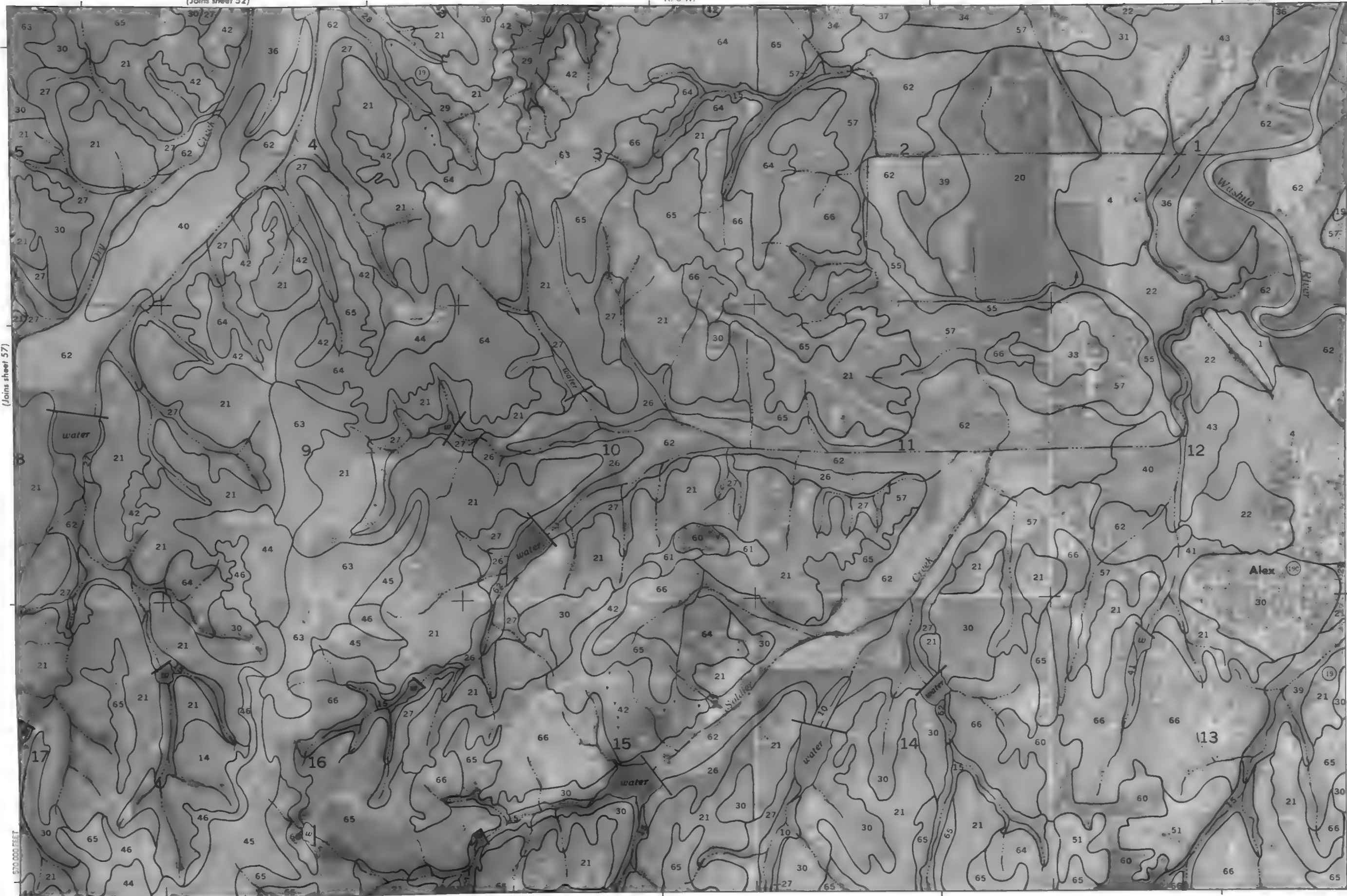
Scale 1:20000





Scale: 1:20000

(Joins sheet 57)



(Joins sheet 52)

R. 6 W.

T. 5 N.

(Joins sheet 63)

(Joins sheet 59)

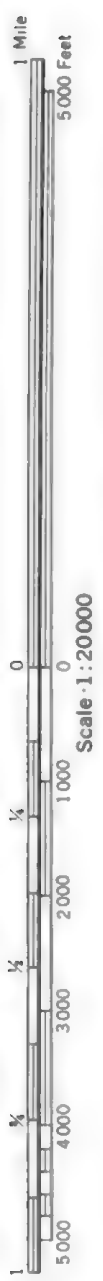




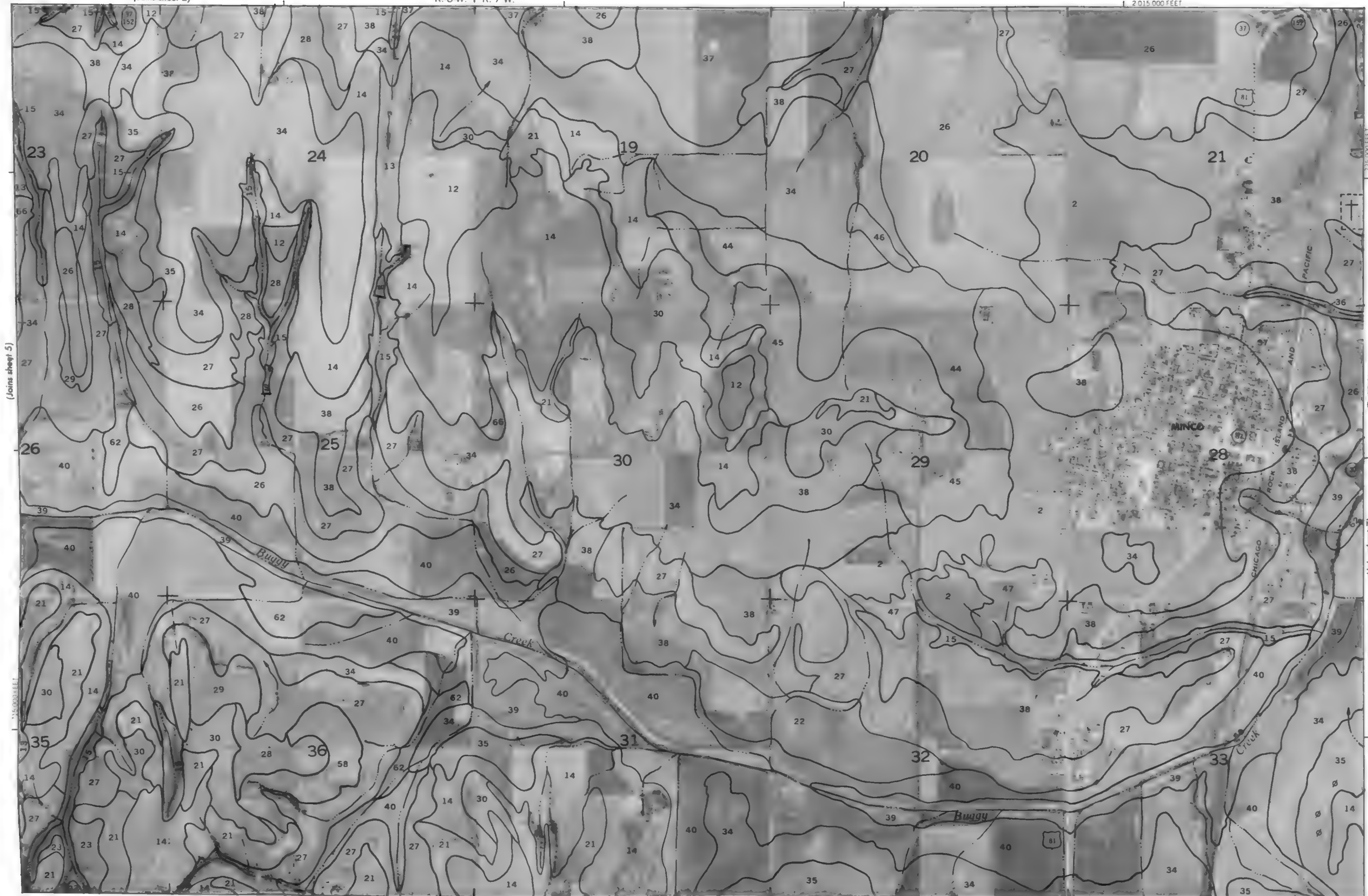
(Joins sheet 2)

R. 8 W. | R. 7 W.

1:2015,000 FEET



(Joins sheet 5)



(Joins sheet 12)

T. 10 N.

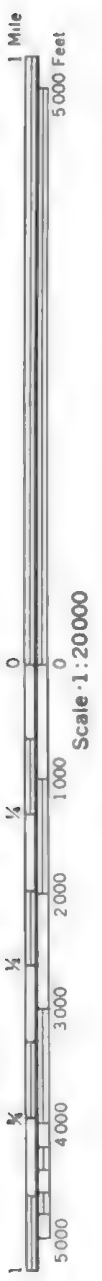
(Joins sheet 7)



(Joins sheet 55)

R. 8 W.

1:62,500 FEET



COMANCHE COUNTY

(Joins sheet 66)

T. 5 N. (Joins sheet 61)



(Joins 66) | (Joins sheet 67)

(Joins sheet 62)

(Joins sheet 56)

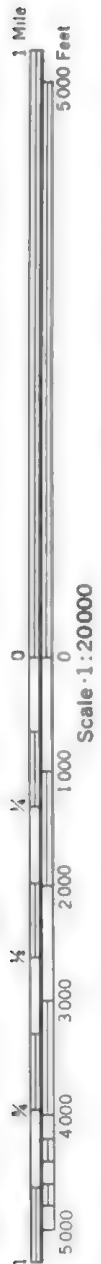




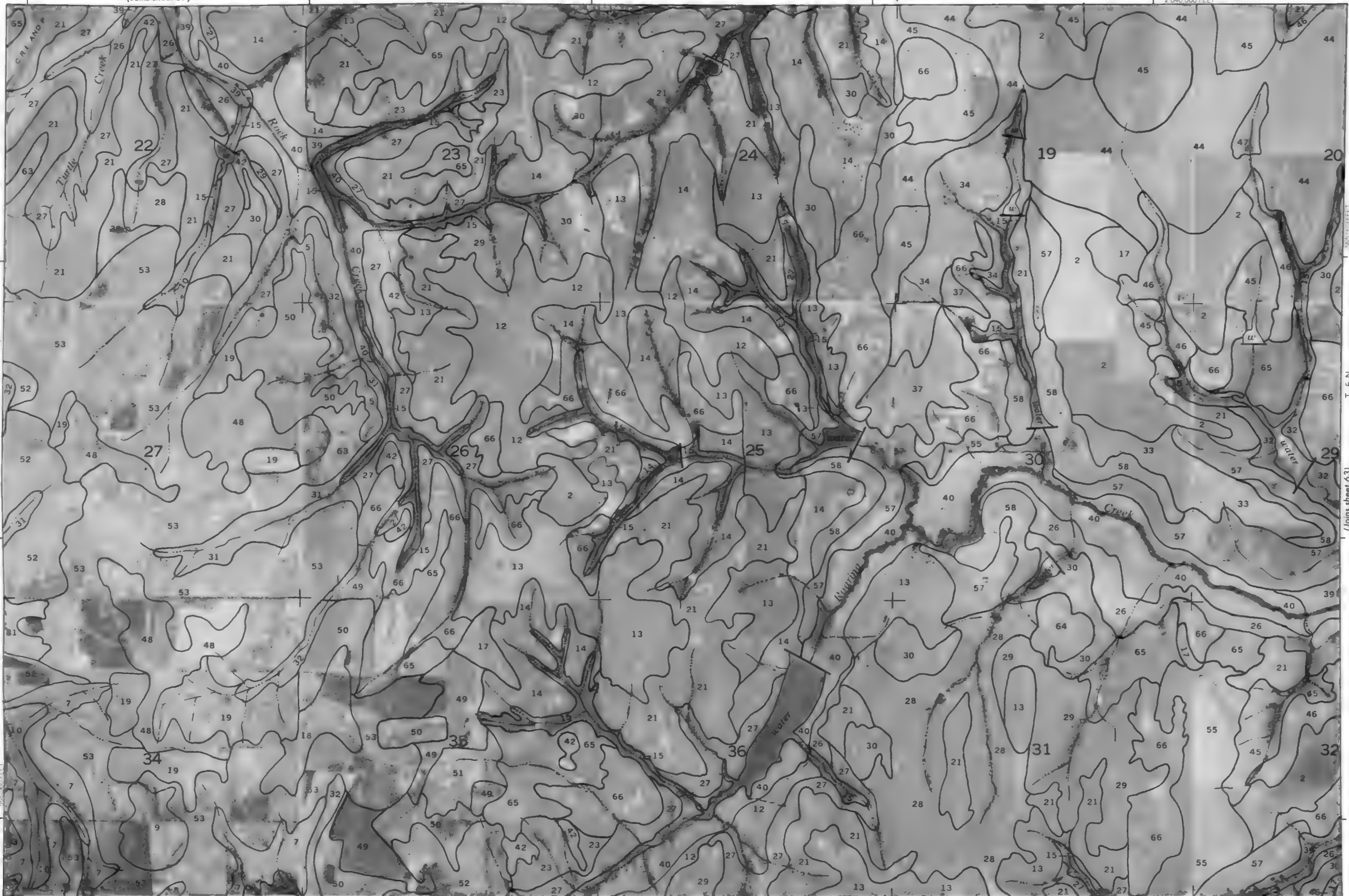
(Joins sheet 57)

R. 7 W. | R. 6 W.

2 040 000 FEET



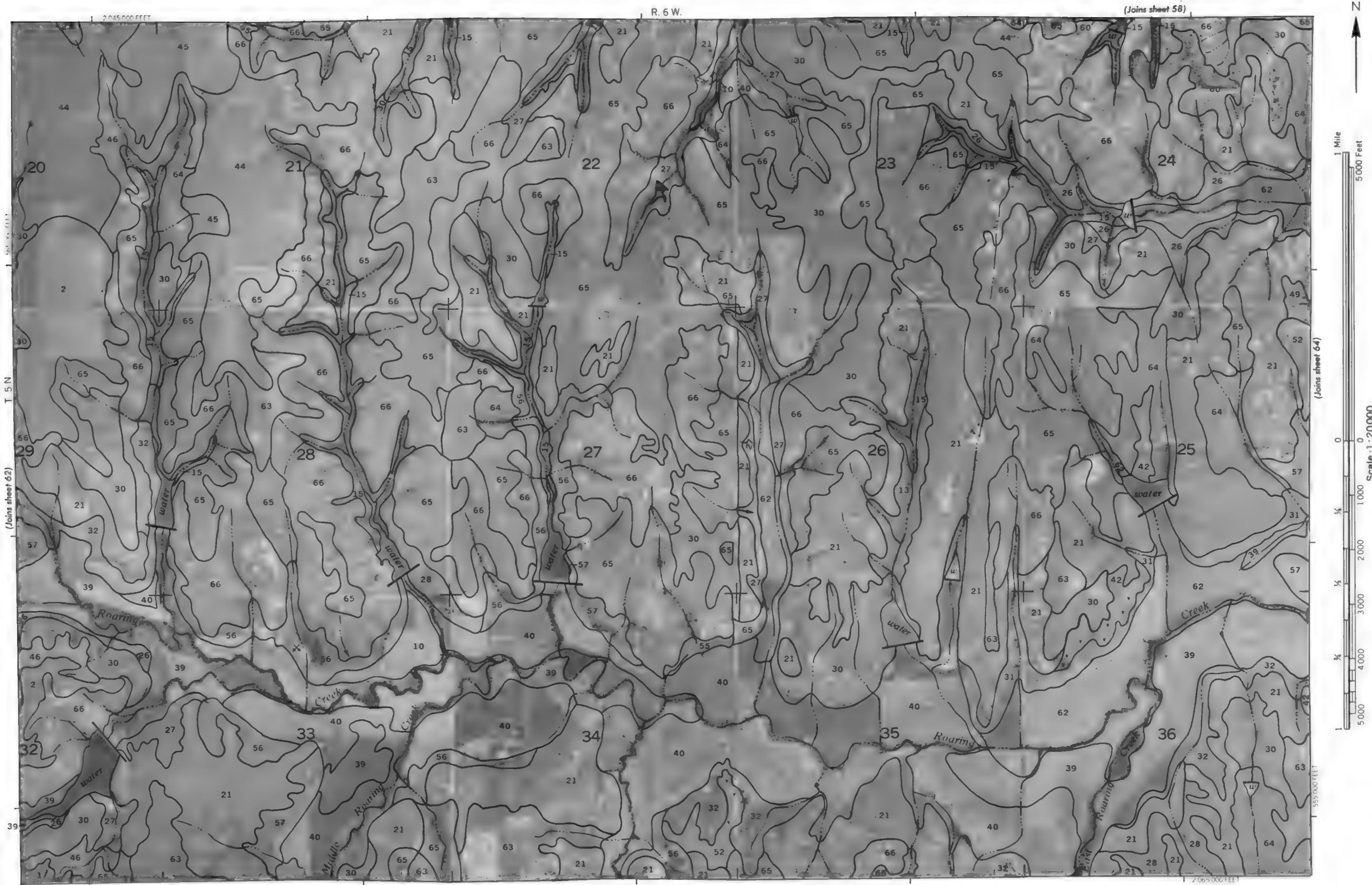
(Joins sheet 61)



T. 5 N.

(Joins sheet 63)

(Joins 67) | (Joins sheet 68)

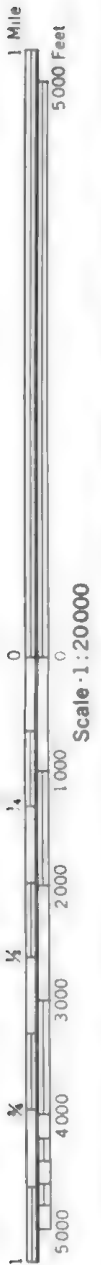




(Joins sheet 59)

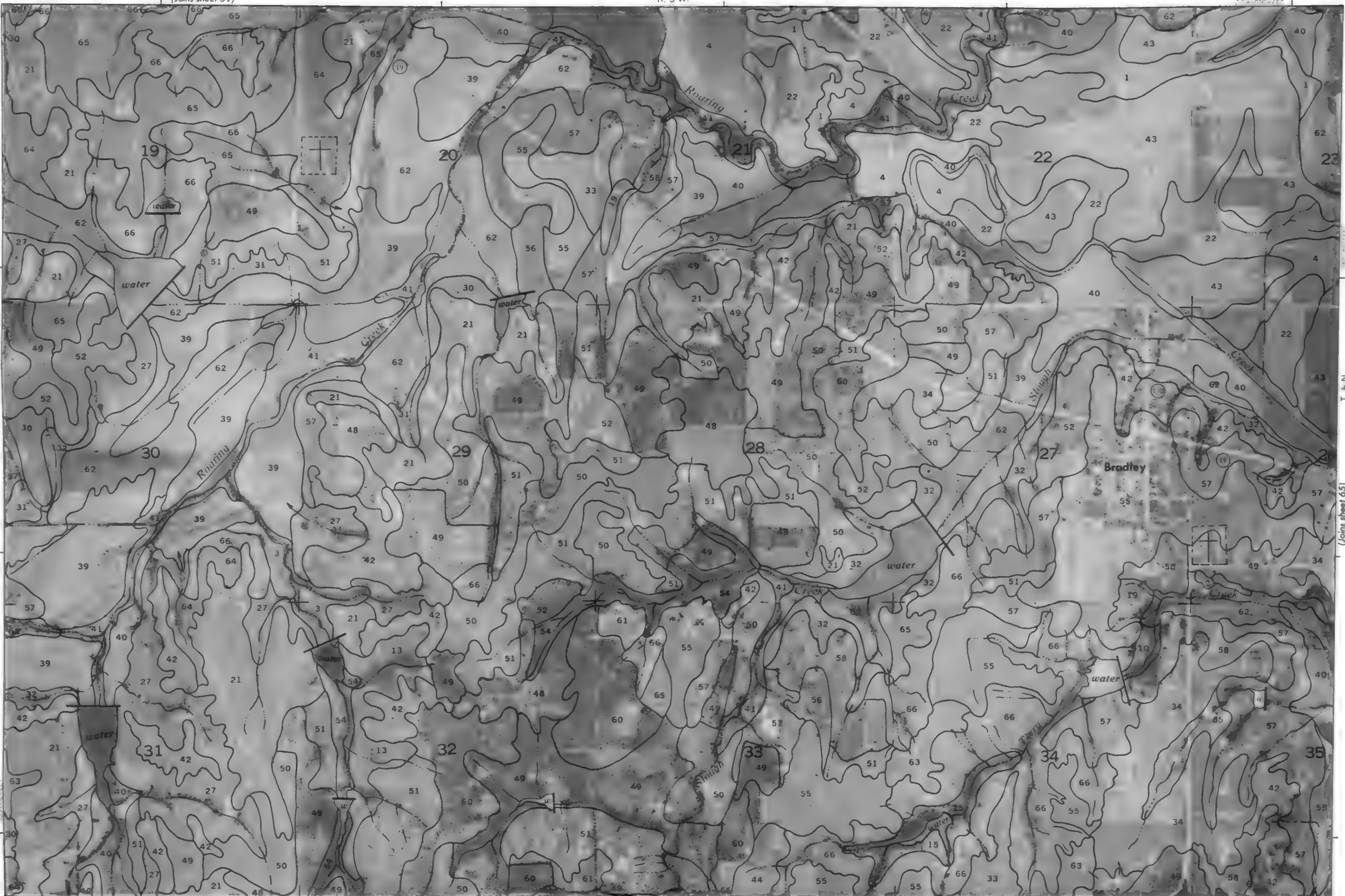
R. 5 W.

T. 5 N.



Scale 1:20000

(Joins sheet 63)

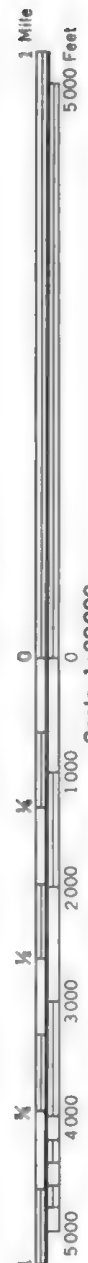
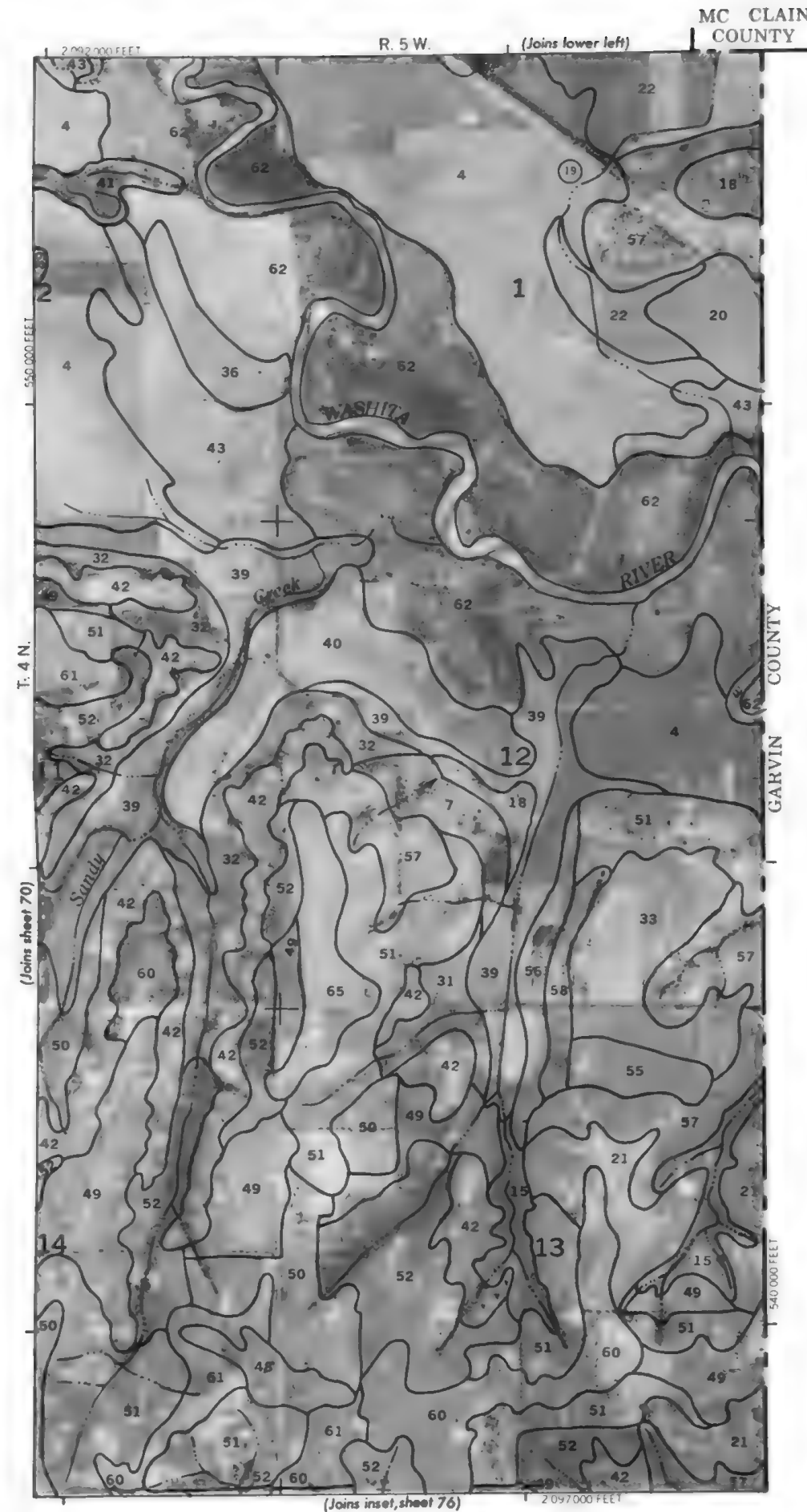
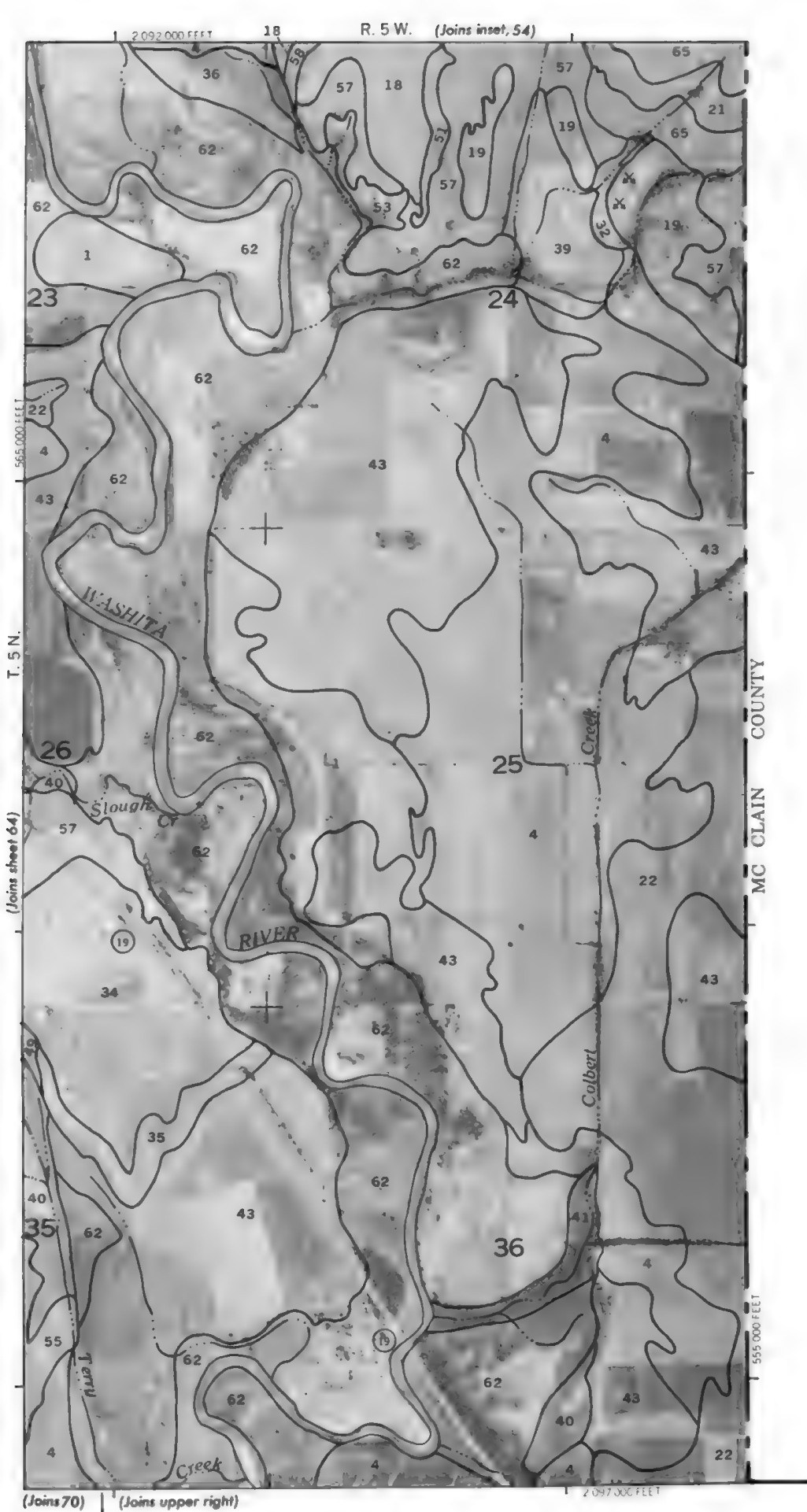


T. 5 N.

(Joins sheet 65)

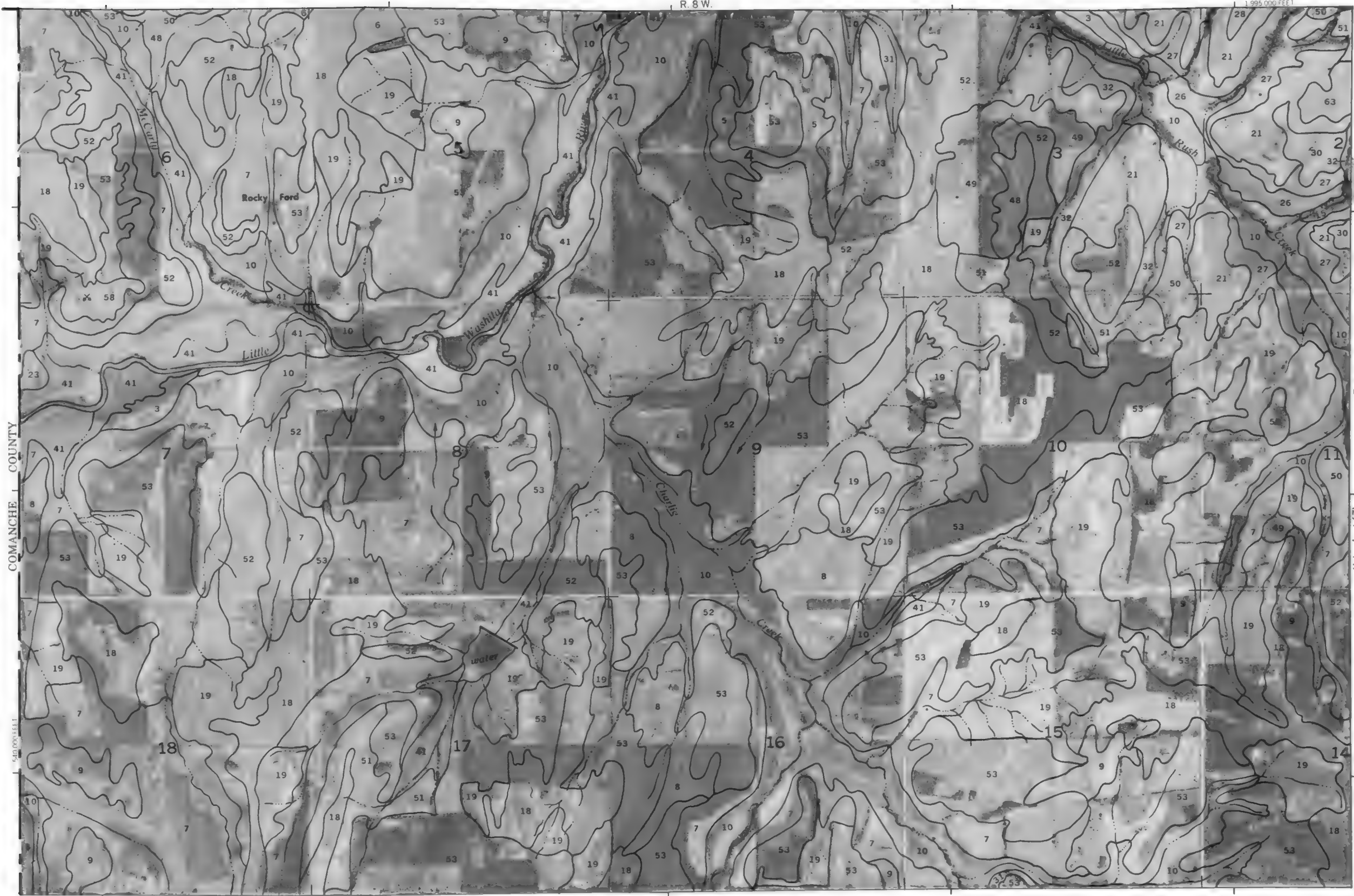
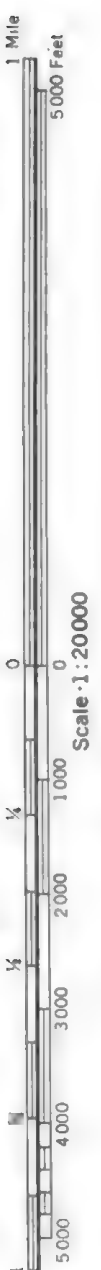
(Joins 69) | (Joins sheet 70)

2070 000 FEET



R. 8 W.

1:995,000 FEET



R. 8 W. | R. 7 W.

(Joins sheet 61) | (Joins 62)

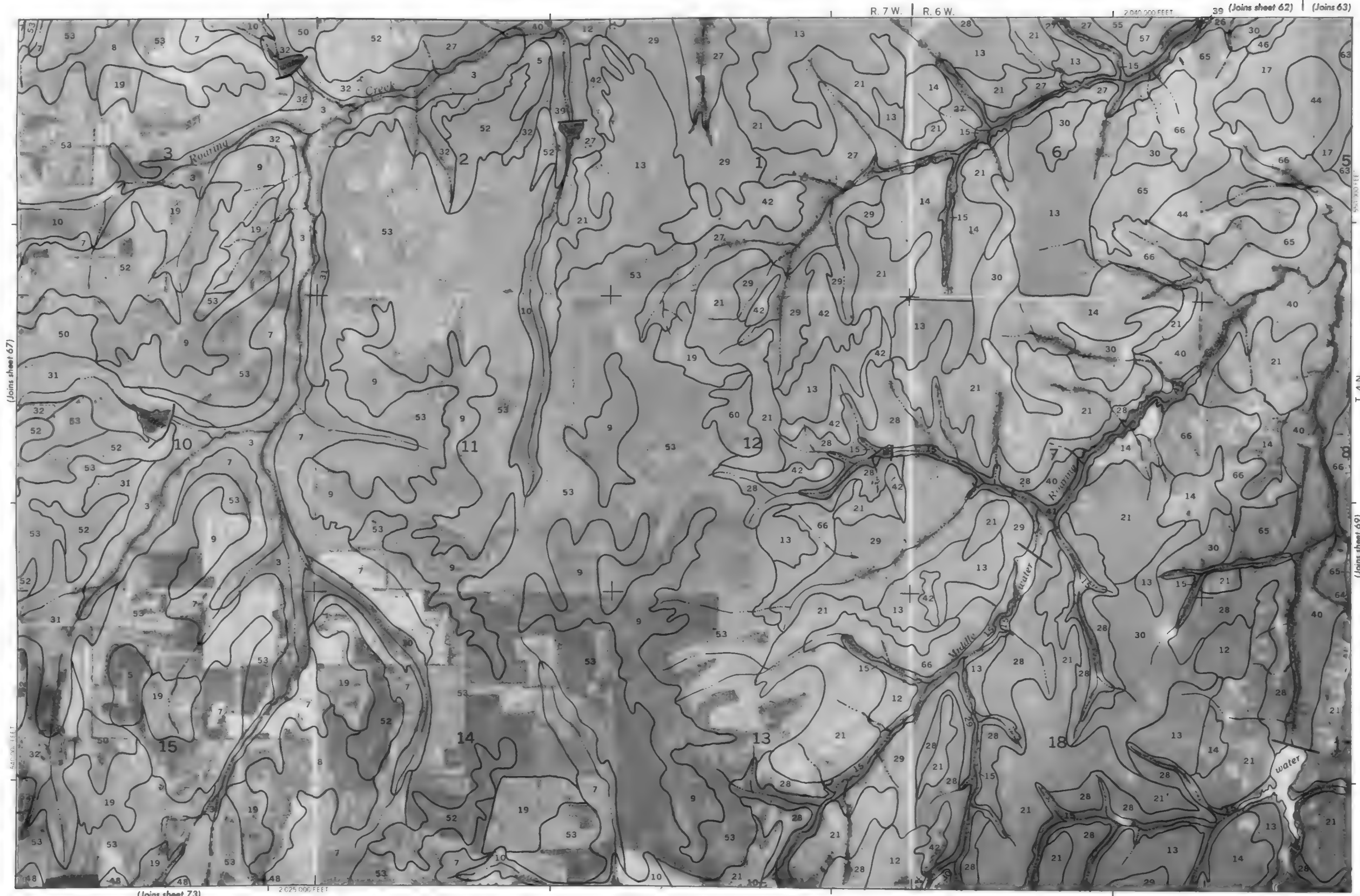
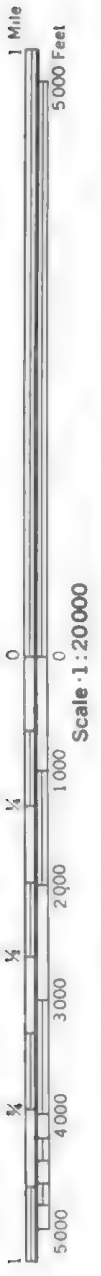


(Joins sheet 72)

2,000,000 FEET

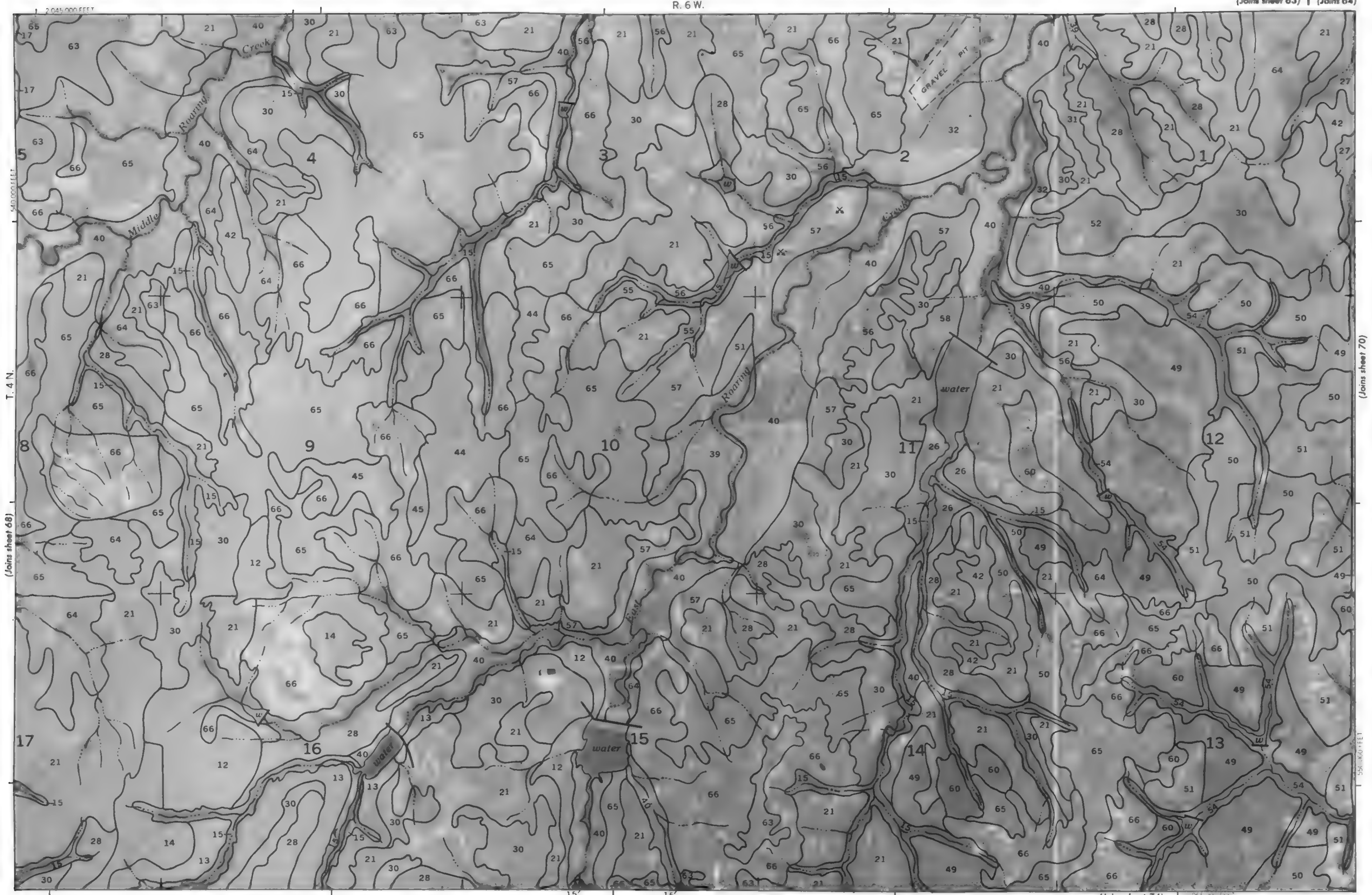


R. 7 W. | R. 6 W. | 2,040 200 FEET 39 (Joins sheet 62) | (Joins 63)



R. 6 W.

(Joins sheet 63) | (Joins sheet 64)



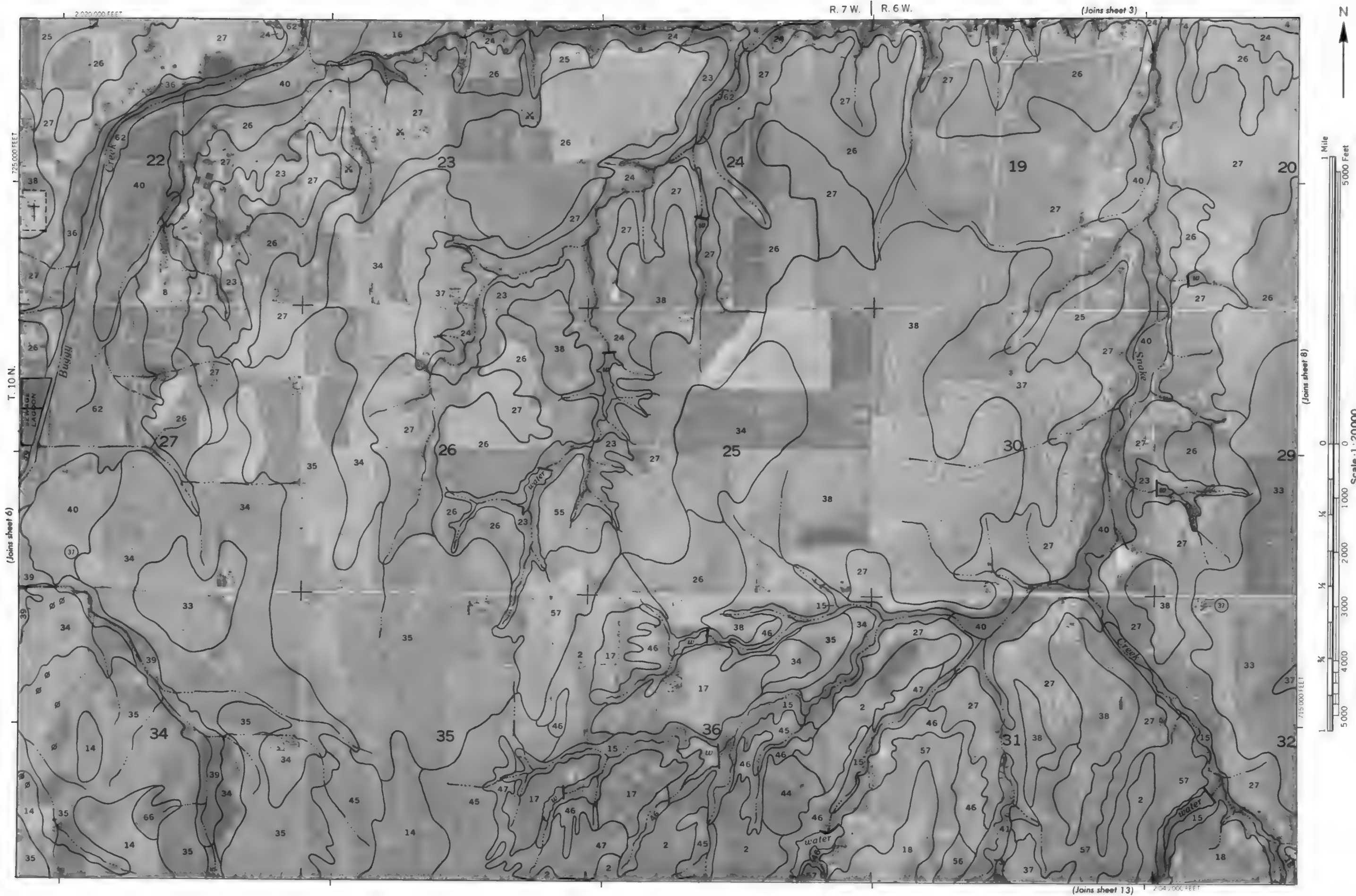
T. 4 N.

(Joins sheet 68)

(Joins sheet 70)

540,000 FEET

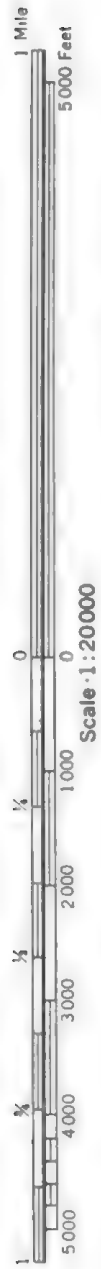
(Joins sheet 74)



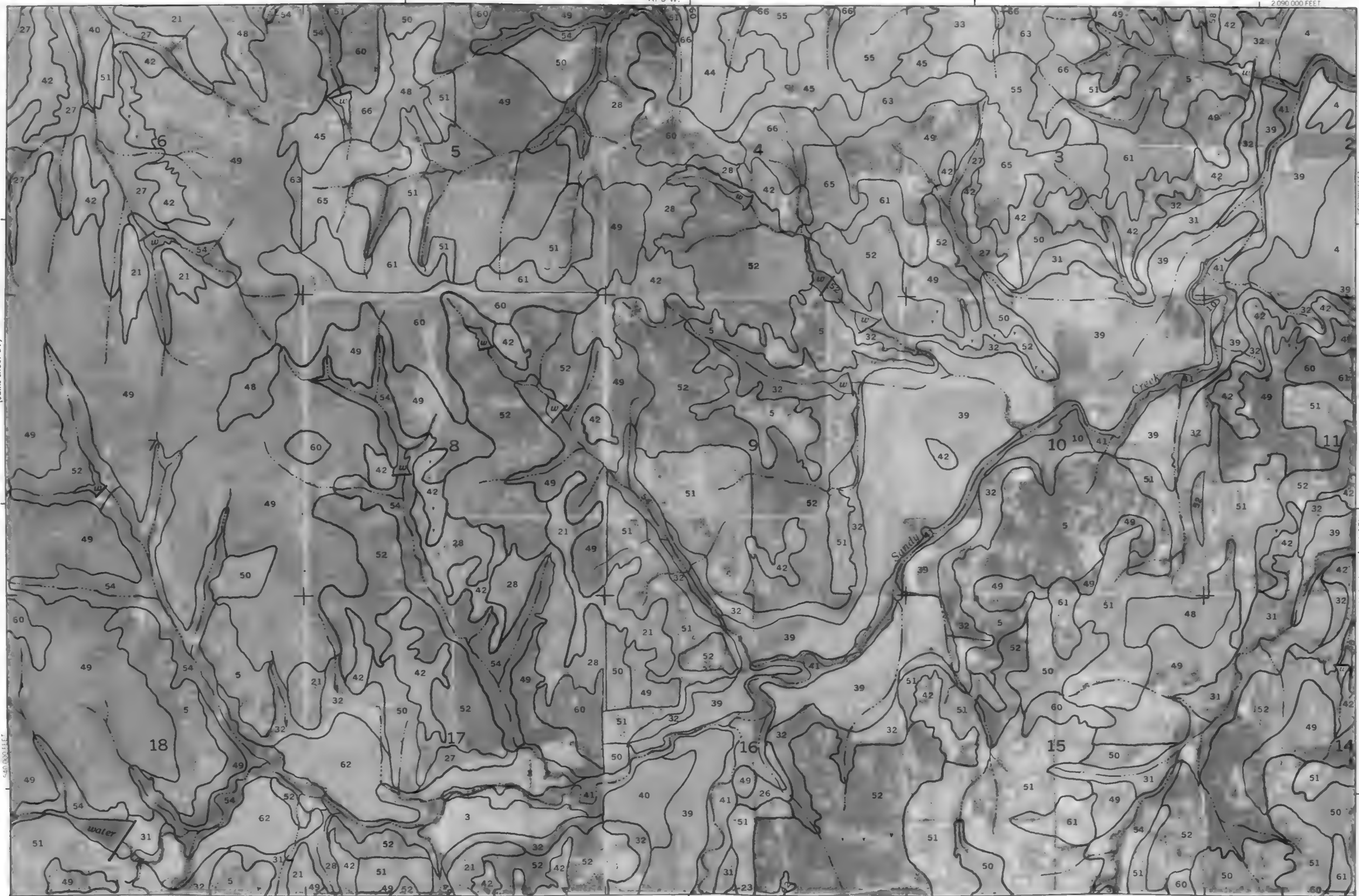


R. 5 W.

(Joins sheet 64) | (Joins 65)
2 090 000 FEET



(Joins sheet 69)

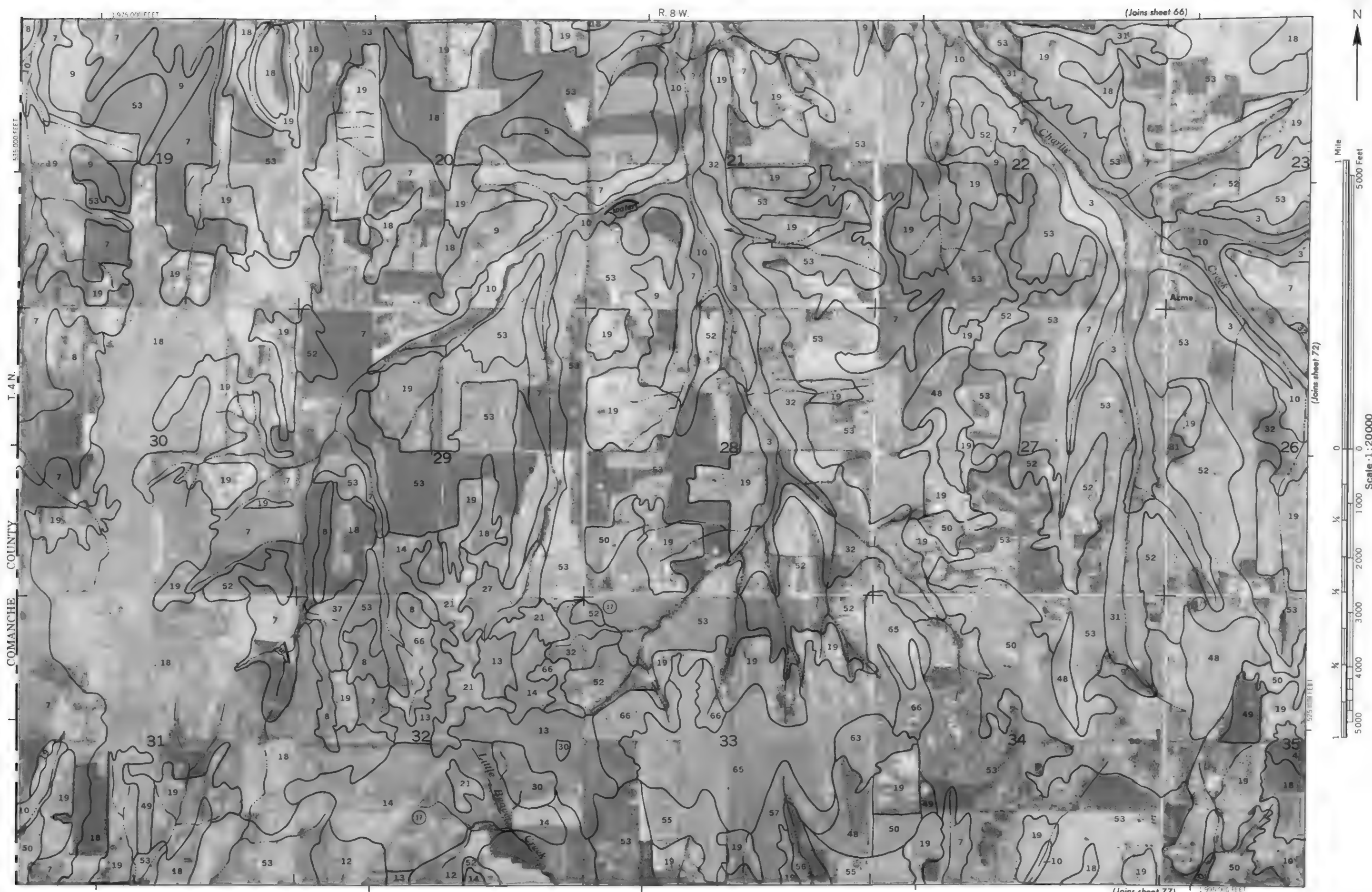


500 000 FEET

T. 4 N.

(Joins inset, sheet 65)

2 070 000 FEET (Joins sheet 75)





Scale 1:20000

(Joins sheet 71)

(Joins sheet 71)

(Joins sheet 67)

R. 8 W. | R. 7 W.

2020 000 FEET

535 000 FEET

T. 4 N.

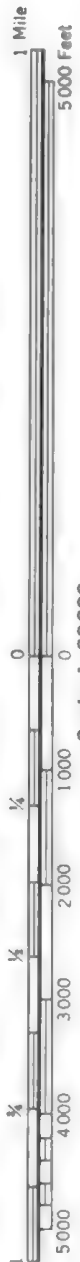
(Joins sheet 73)



2000 000 FEET (Joins sheet 78)

R. 7 W. | R. 6 W.

(Joins sheet 68)



(Joins sheet 74)

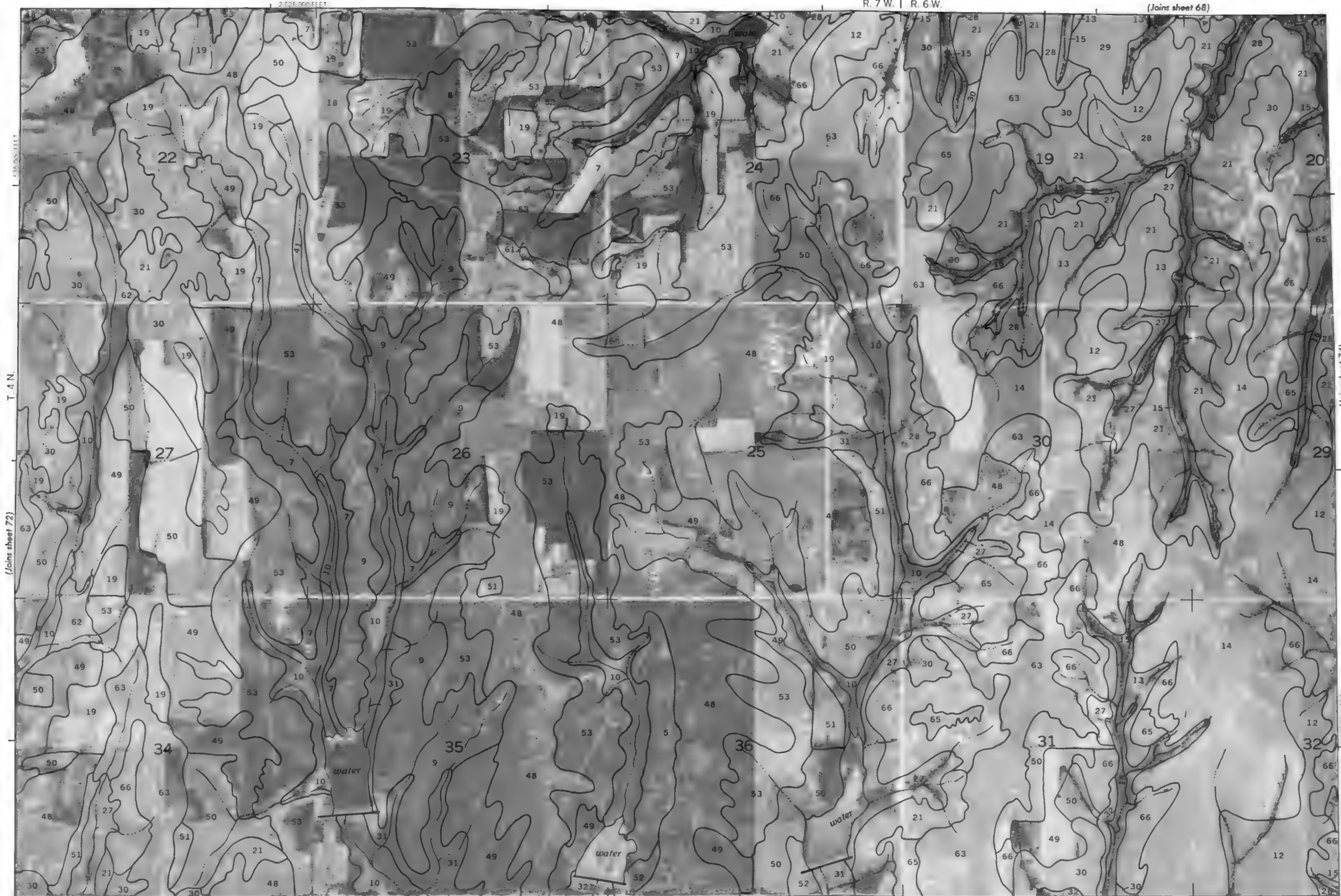
5000 FEET

(Joins sheet 79)

(Joins sheet 72)

T. 4 N.

5000 FEET

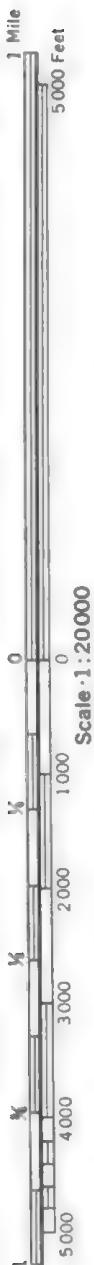




(Joins sheet 69)

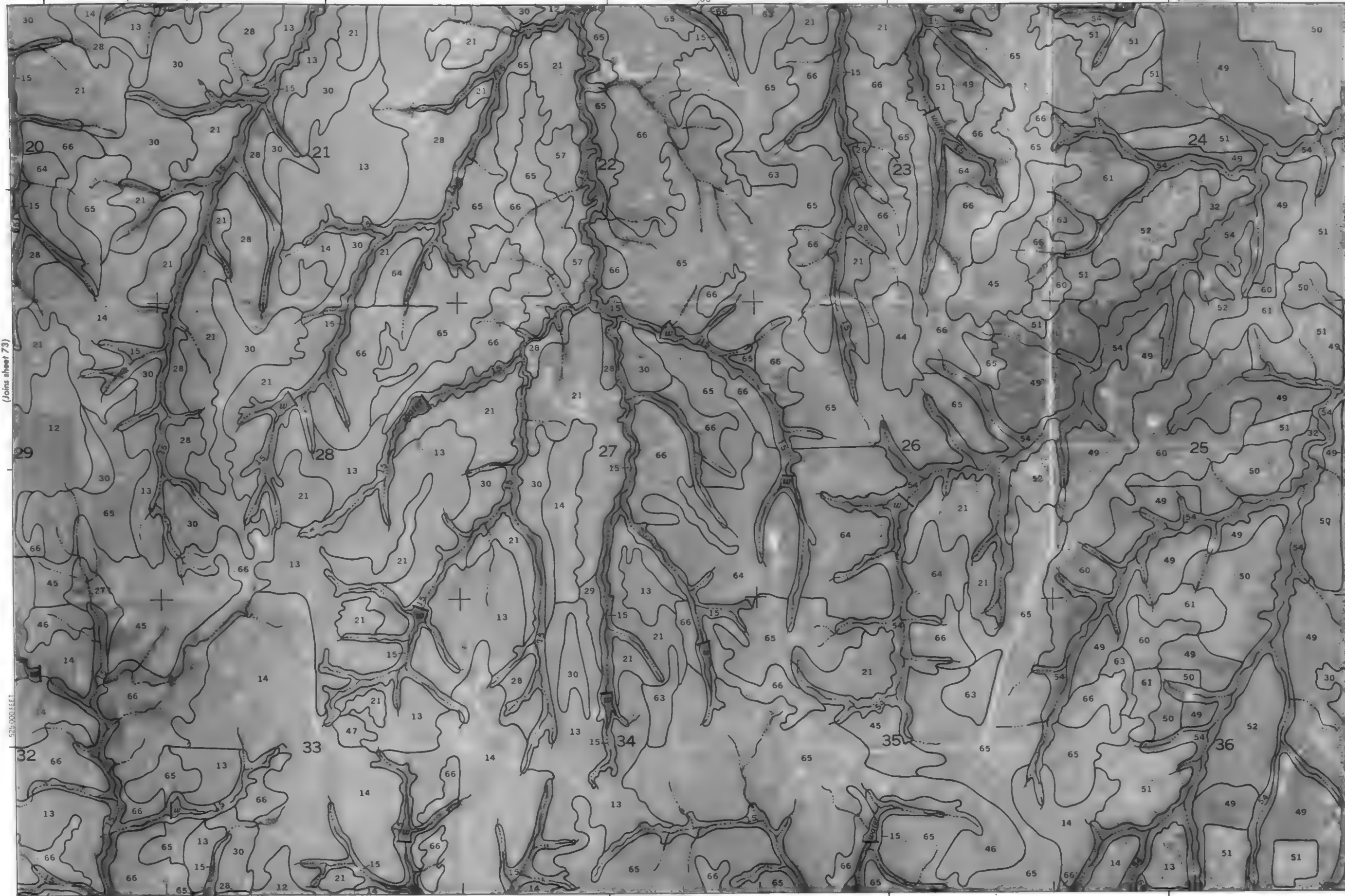
R. 6 W. 63

2 064 000 FEET



(Joins sheet 73)

Scale 1:20000



T. 4 N.

(Joins sheet 75)

28 2 045 000 FEET

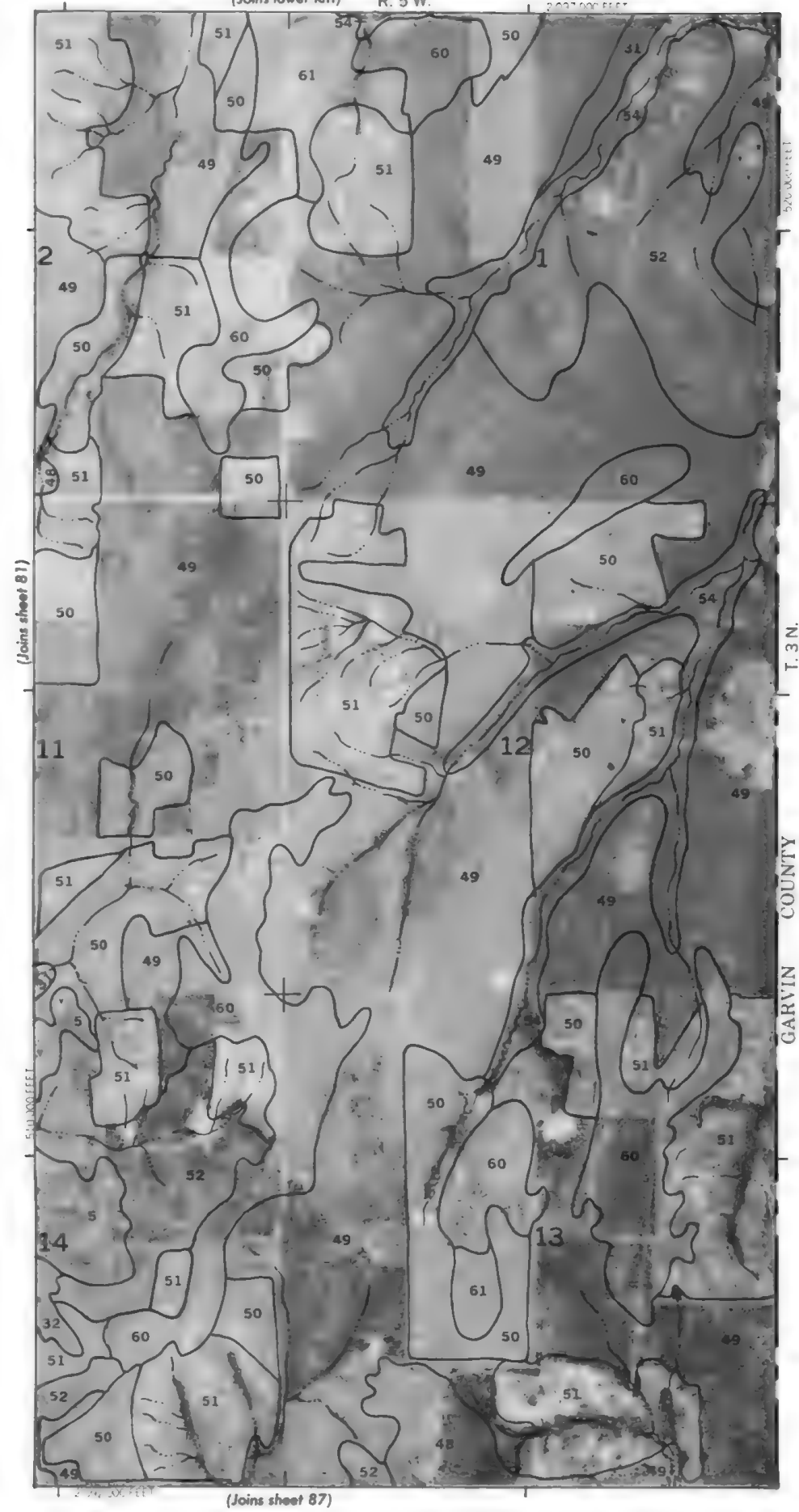
(Joins sheet 80)

200' 000 FEET



R. 5 W

2027000 EE



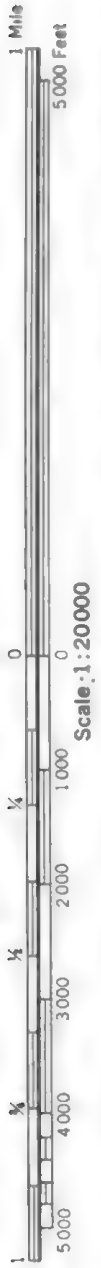




(Joins sheet 72)

R. 8 W. | R. 7 W.

2000 FEET



(Joins sheet 77)



T. 3 N.

(Joins sheet 79)

(Joins sheet 83)

R. 7 W. | R. 6 W.

(Joins sheet 73)

2,025,000 FEET



(Joins sheet 80)

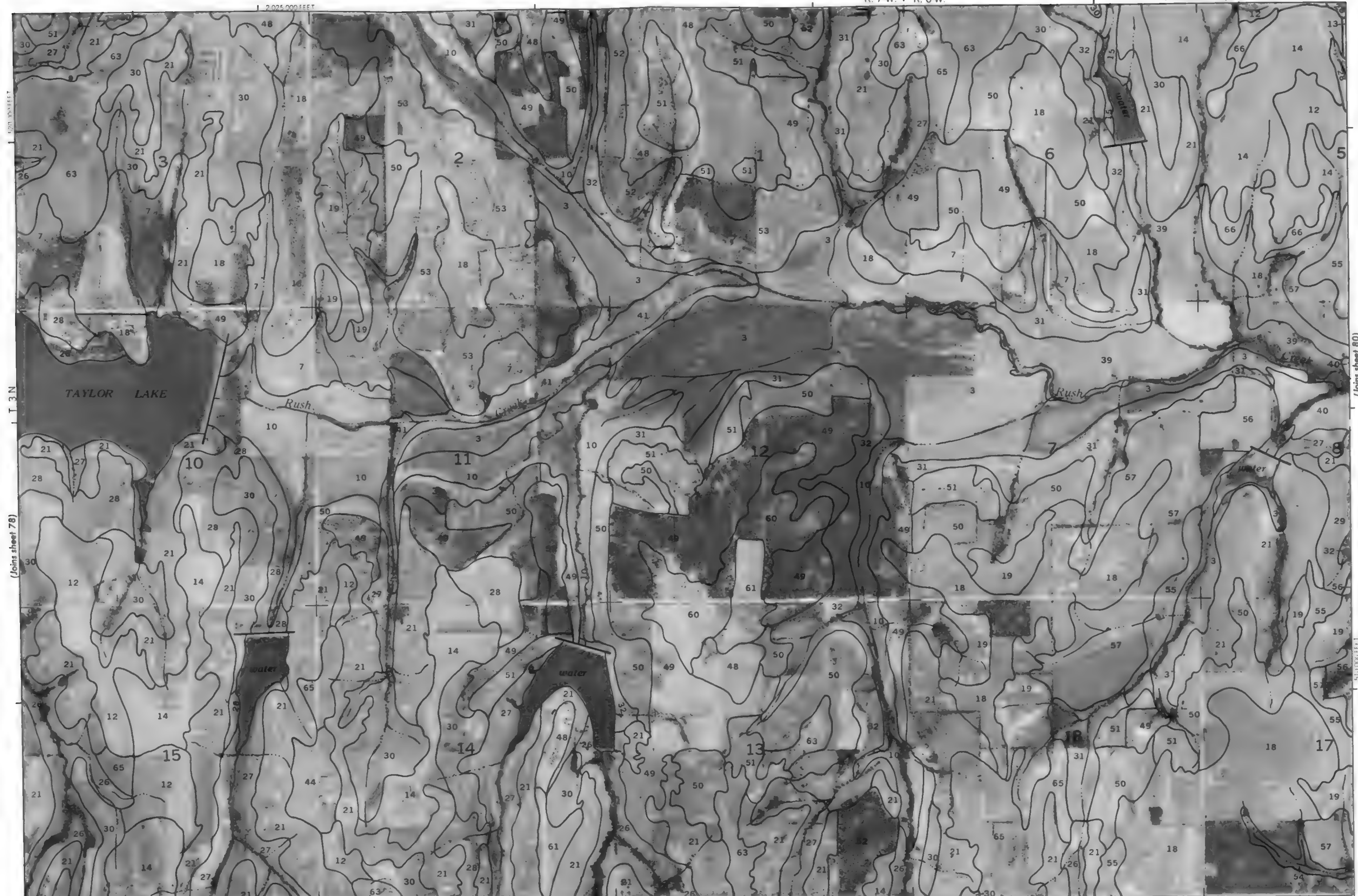
510000 FEET

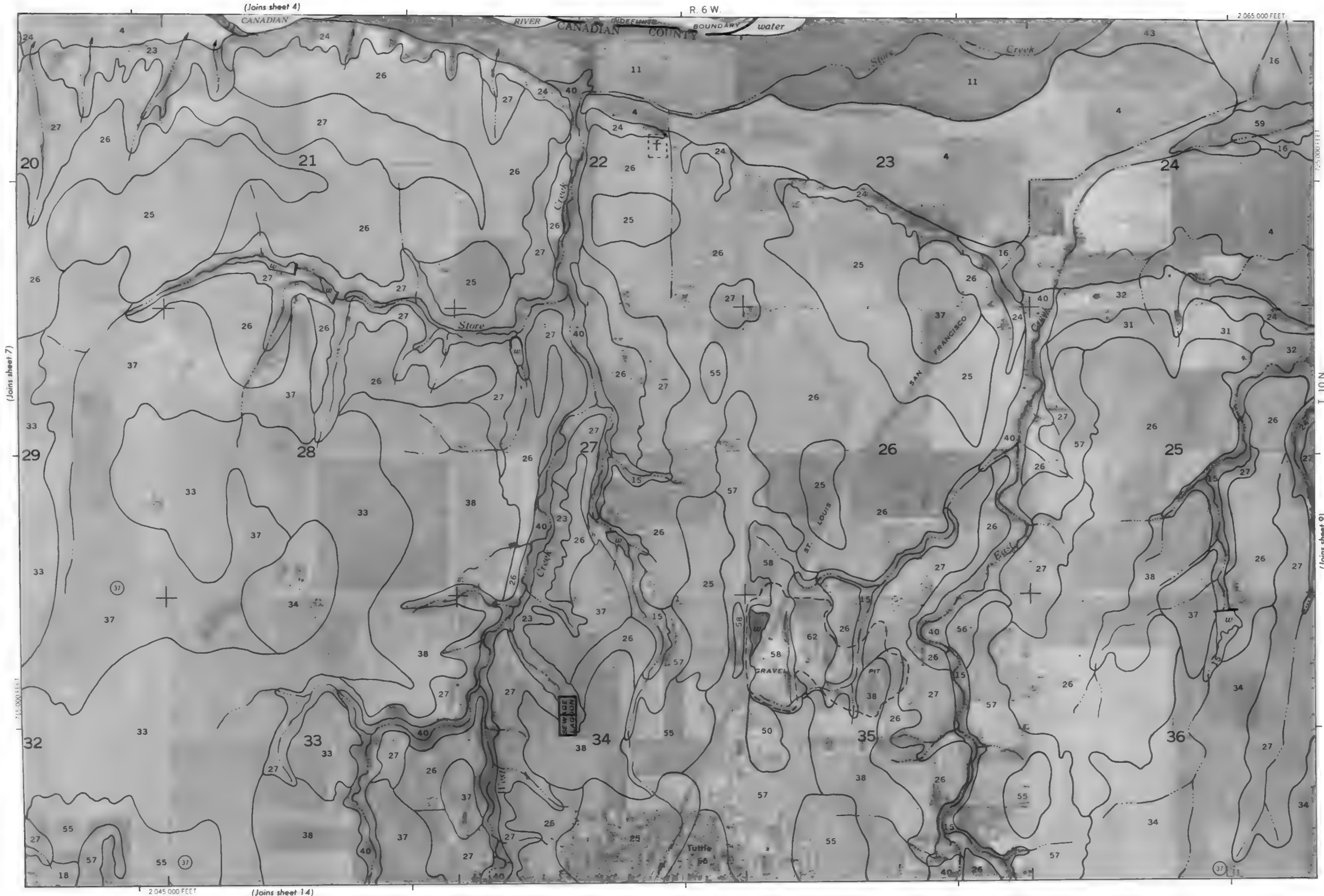
2,640,000 FEET (Joins sheet 84)

(Joins sheet 78)

T. 3 N.

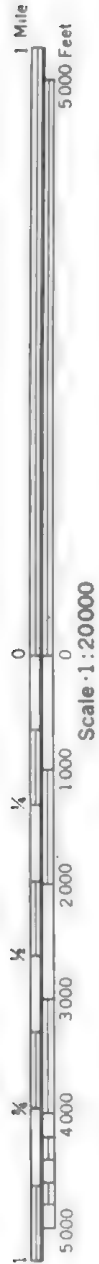
1000 FEET





(Joins sheet 74)

R. 6 W.



(Joins sheet 79)



T. 3 N.

(Joins sheet 81)

(Joins sheet 85)

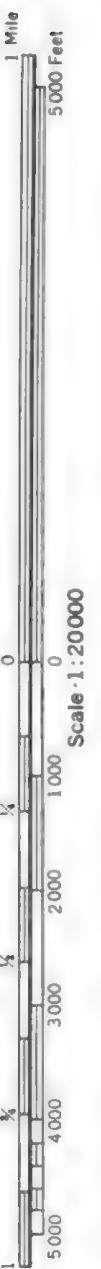
55'



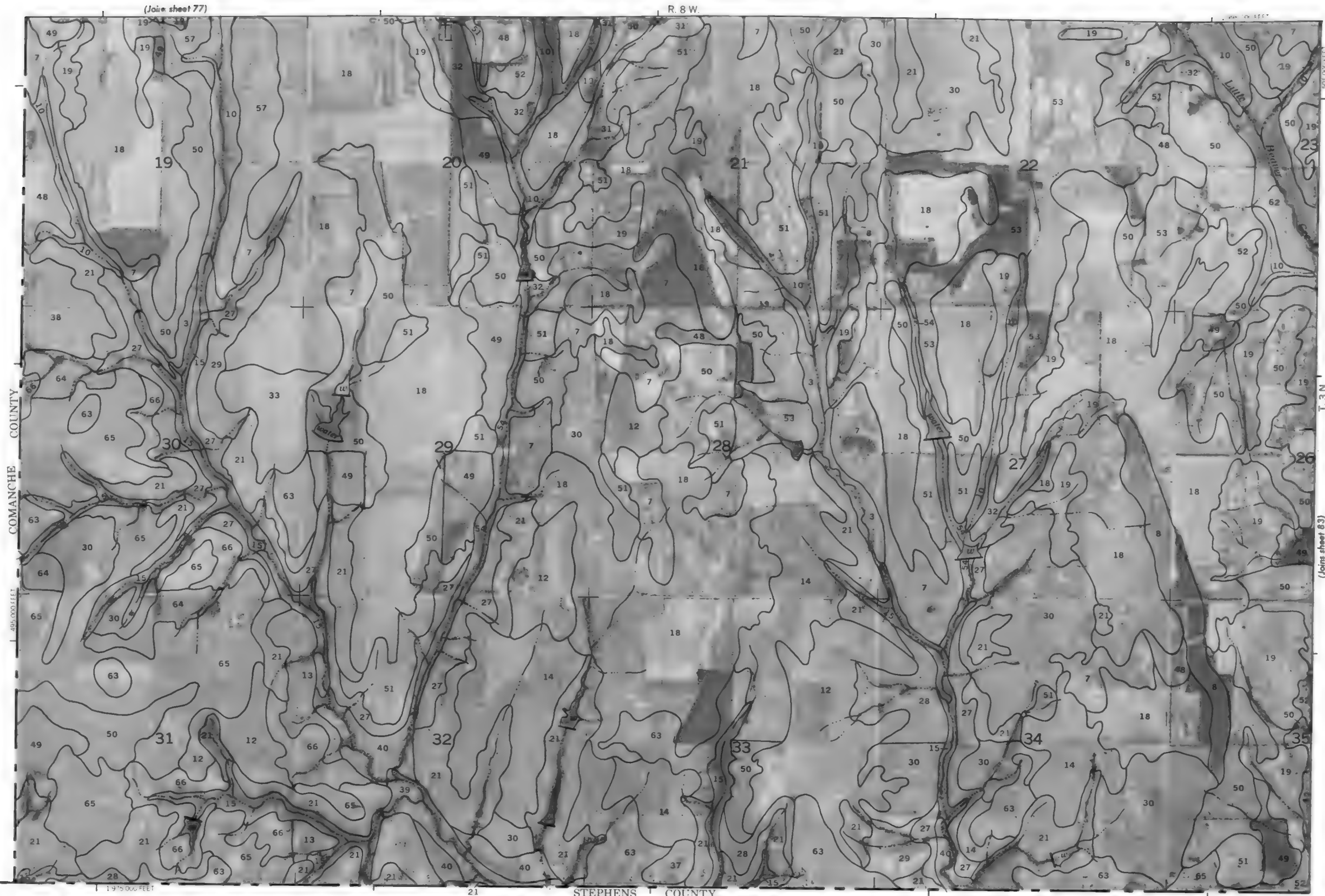


(Join sheet 77)

R. 8 W.



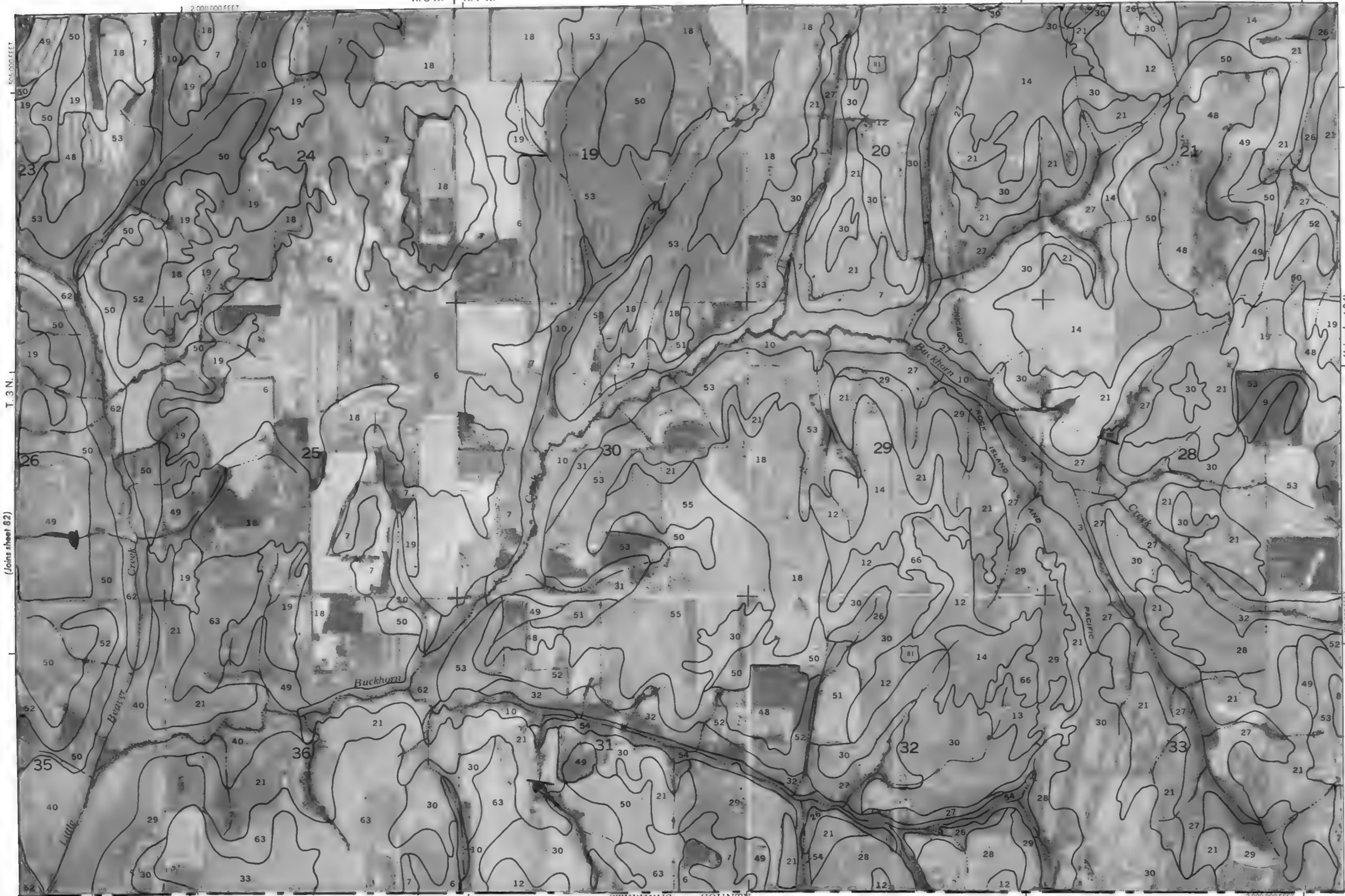
Scale 1:20000



(Join sheet 83)

R.8 W. | R.7 W.

(Joins sheet 78)



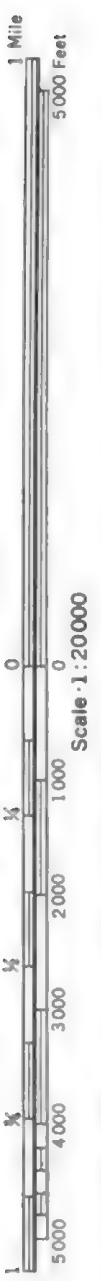
Scale 1:20000



(Joins sheet 79)

R. 7 W. | R. 6 W.

2,048 FEET



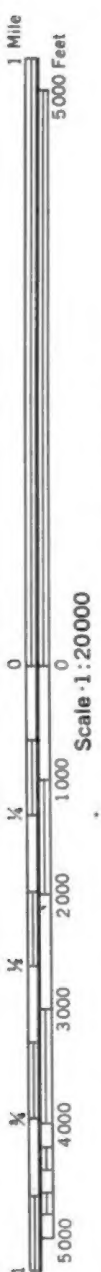
(Joins sheet 83)

T. 3 N.
(Joins sheet 85)

2,025,000 FEET

STEPHENS COUNTY



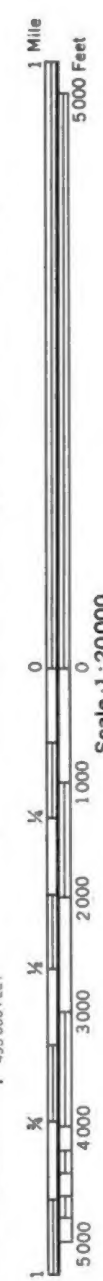




R. 5 W. 2,095,000 FEET (Joins inset, sheet 76)

(Joins sheet 86)

T. 3 N.



STEPHENS COUNTY

GARVIN COUNTY

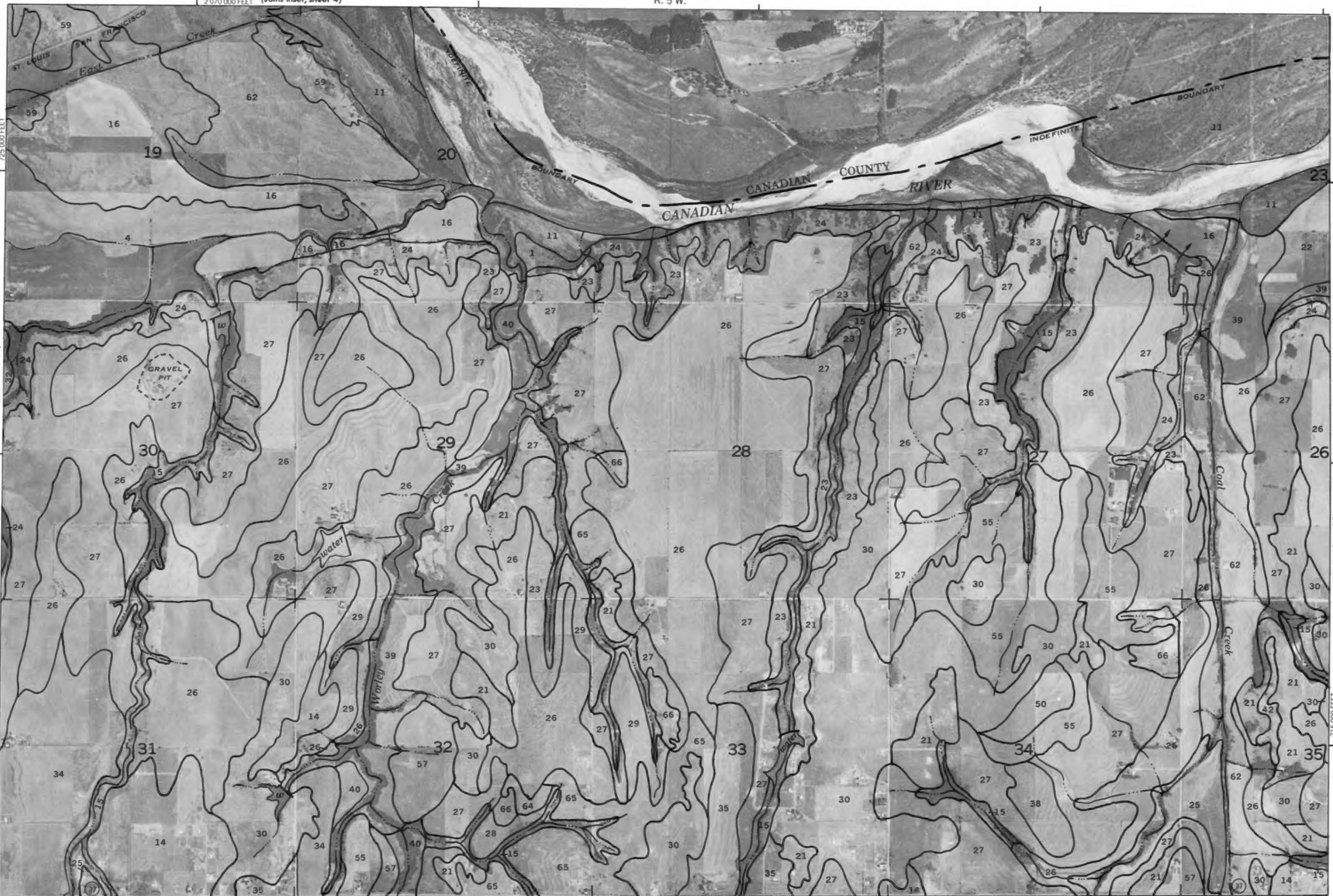
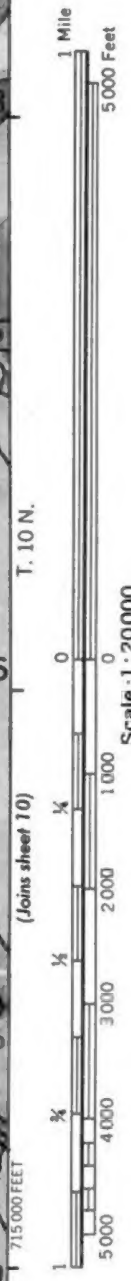
2,115,000 FEET

2 070 000 FEET (Joins inset, sheet 4)

R. 5 W.



(Joins sheet 8)



(Joins sheet 15)

2 090 000 FEET